

r



BEST AVAILABLE COPY

HYDROCATALYSIS: A New Energy Paradigm for the 21st Century

by Peter Mark Jansson, P.P., P.E.

A Thesis

Submitted in partial fulfillment of the requirements of the Master of Science in Engineering Degree in the Graduate Division of Rowan University

May 1997





THIS PAGE BLANK (USPTO)





HYDROCATALYSIS: A New Energy Paradigm

for the 21st Century

by Peter Mark Jansson, P.P., P.E.

A Thesis

Submitted in partial fulfillment of the requirements of the Master of Science in Engineering Degree in the Graduate Division of Rowan University

May 1997

Approved by Trujnith R. Chandrupatha
Dr. Tirupathi R. Chandrupatha

Approved by _______
Dr. Anthony J. Marchese

External Advisors

Dr. Jonathan Phillips - Pennsylvania State University

Dr. Randell L. Mills - BlackLight Power, Inc.

William R. Good - BlackLight Power, Inc.





THIS PAGE BLANK (USPTO)





Copyright © 1997 by Peter Mark Jansson

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrievel system now known or to be invented, without prior permission in writing from the author, except by a reviewer or other researcher who wish to quote brief passages in connection with a review written for inclusion in a magazine, newspaper, internet web page, broadcast or research for other scholarly purposes.

Library of Congress - Cataloguing in Progress

Published in the United States by
Peter Mark Jansson, P.P.,P.E.
Integrated Systems
P.O. Box 4
Tuckerton, New Jersey, 08087-0004





THIS PAGE BLANK (USPTO)





to Joy,

who encouraged me to return to college ever since we left

:





THIS PAGE BLANK (USPTO)





TABLE OF CONTENTS

				Pa	_
Table of Contents				i i	ii
List of Tables				i	v
List of Figures		• • • • • • •			
Abstract					
Mini Absract					
Introduction and Thesis Overview				••••	1
PART I - An Energy Technology Over					
Chapter 1 - Alternate Technolog	gy Overview		• • • • • •		4
1.1 Fossil Fuels			• • • • • •	• • • • •	J .
1.2 Nuclear Energy -				•	
Fission & Fusio	n .		• • • • • •	• • • • •	11
1.3 Solar Energy			• • • • • •	• • • • •	14
1.4 Geothermal Energy				• • • • •	19
1.5 Tidal Energy		•••••	• • • • • •		20
Chapter 2 - Overview of Mills	Technology				21
2.1 HydroCatalysis - A	Theoretical				
2.1 Ayar o Calalysis 11 Overview					
2.2 Astrophysical Corr	oboration				25
2.2 Astrophysical College	000,				28
2.3 Enigmas Solved 2.4 Technological Emb	oodiments	• • • • • •			. 29
PART II - Analysis of Previous Exper	imental Resul	<u>ts</u>	• • • • • •		. 36
Chapter 3 - Summary Review					
Chapter 3 - Summary Review Cell Experime	ntal Results				. 36
3.1 BlackLight Power	Teathermal Ca	,11			. 37
3.1 BlackLight Power	isomer mai Ce	··· · · · · · · · · · · · · · · · · ·			. 39
3.2 Penn State Univer	suy Cuivei	• • • • •			. 41
3.3 Jansson Calvet		• • • • •	•••••		





TABLE OF CONTENTS [continued]

	Page
PART III - Mathematical Model	52
Chapter 4 - Analysis of Model Performance vs. Experimental Results	52
Chapter 5 - Key Learnings and Insights from Model	57
PART IV - Implications for the Future	63
Chapter 6 - Implications for the Future and	
Recommended Next Steps	64
PART V - Reference Materials	66
Footnotes	67
Description of Appendices	72
List of Appendices	·
Appendix 1. BLP Research Partners - Catal	ogue of Experimental Results
Appendix 2. An Overview of Mills Theory	
Appendix 3. Jansson Astrophysical Data Co Reported Results	alculations verifying BLP
Appendix 4. BLP/AEI Experiment 15.6 - M	May 1996
Appendix 5. Analysis of BLP Isothermal C	alorimetry Data
Appendix 6. PSU Calvet Test Results and I	Report - December 1996
Appendix 7. Jansson Calvet Testing Protoc	ol - 1007
Appendix 8. Jansson Calvet Test Results -	June 199/
Appendix 9. Jansson Heat Loss Model Cal	ioration & Periormance





LIST OF TABLES

	Page	
TABLE 1.1 - 1995 Energy Use by Fuel Type	3	
TABLE 1.1 - 1995 Energy Courses and Technologies	4	
TADIE 13 - Energy Release Processes for Possii Fuels	5	
TADIE 1 A - Fossil Fuel Reserves and Resource Litetimes		
To the property of Nuclear Files	12	
TABLE 1.5 - Energy Release Processes for Nuclear 1 des TABLE 1.6 - Nuclear Fission By-Products Radioactive Half-lives	13	
TADIE 2.1. Blacklight Power Research Partiers		
TABLE 2.2 Energy Released From Lower Energy Hydrogen	23	
TABLE 2.3 - Commonly Observed Wavelengths & Mills Theory	28	
TABLE 2.4 - BLP Technologies	30	
TABLE 25 - The Search for Hydrinos	34	
TABLE 3.1 - Isothermal Cell Results Summary	39	
TARIE 3 2 - Penn State Calvet Cell Results Summary	40	,
TARIE 3 3 - Jansson Calvet Testing Objectives	41	,
Toete Completed		,
TABLE 2.5 Jansson Calvet Testing Protocol Summary - Conduct	43	
TADIE 3.6 - Jansson Calvet Testing Protocol Summary - Exps.	43	
TABLE 3.7 - Jansson Calvet Testing - Calibration Curves	44	1
TADIE 3 8 - Jansson Calvet Cell Results Summary		2
TABIE 4.1 - Isothermal Cell Results - May 3-4, 1990		- 3
TADIE 42 - Isothermal Cell Heat Loss vs. 1 emperature	6.	3
TABLE 4.2 - Isotherman Control of Table		_

Appendix 2

TABLE A.1 - Mills' Theory Predictions
TABLE A.2 - The Electron Orbitsphere





LIST OF FIGURES

	Page
FIGURE 1.1 - Relationship Between Energy Consumption	
and Economic Activity (1971)	9
FIGURE 1.2 - Per Capita GNP vs. Per Capita Energy	
Consumption (1987)	10
FIGURE 1.3 - Neutron Induced Fission of ²³⁵ U	11
FIGURE 1.4 - PV Historical Costs 1958-1996	18
FIGURE 2.1 - Quantized Sizes of Hydrogen Atoms	24
FIGURE 2.1 - Quantized Sizes of Trydrogen 1 tollar FIGURE 2.2 - Astrophysical Observations and Mill's Theory	27
FIGURE 2.2 - Astrophysical Observations and with 5 Indexy FIGURE 2.3 - Astrophysical Data vs. Mill's Theory Illustrated	27
FIGURE 2.3 - Astrophysical Data vs. with a Theory musuated	31
FIGURE 2.4 - Dewar Experimental Vessel	
FIGURE 2.5 - Advanced Electrolytic Cell	
FIGURE 2.6 - Non-Electrolytic Gas Phase Cell	
FIGURE 2.7 - Isothermal Calorimeter Gas Phase Cell	
FIGURE 2.8 - Calvet Calorimeter Gas Phase Cell	
FIGURE 2.9 - XPS Anomalous 55 eV Peaks	
FIGURE 3.1 - Excess Power vs. Filament Length	
FIGURE 3.2 - Summary of 10 cm Experimental Results	46
FIGURE 3.3 - Calibration Curve 10 cm. Control	47
FIGURE 3.4 - Summary of 20 cm Experimental Results	48
FIGURE 3.5 - Calibration Curve 20 cm. Control	49
FIGURE 3.6 - Summary of 30 cm Experimental Results	50
FIGURE 3.7 - Calibration Curve 30 cm. Control	51
FIGURE 4.1 - Isothermal Cell Performance May 4, 1996	54
FIGURE 4.2 - Isothermal Model vs. Actual Performance	55
FIGURE 4.3 - Isothermal Cell Heat Loss vs. Temperature	56

Appendix 2
FIGURE A.1 - The Electron Orbitsphere
FIGURE A.2 - The Electron Orbitsphere







ABSTRACT

Peter Mark Jansson, P.P., P.E. HYDROCATALYSIS: A NEW ENERGY PARADIGM FOR THE 21st CENTURY May 1997

Dr. John L.Schmalzel, P.E. - Thesis Advisor Graduate Engineering Department

This thesis will review the problems of worldwide energy supply, describe the current technologies that meet the energy needs of our industrial societies, summarize the environmental impacts of those fuels and technologies and their increased use by a growing global and increasingly technical economy. This work will also describe and advance the technology being developed by BlackLight Power, Inc. [BLP], a scientific company located in Malvern, Pennsylvania. BLP's technology proports to offer commercially viable and useful heat generation via a previously unrecognized natural phenomenon - the catalytic reduction of the hydrogen atom to a lower energy state. A review of this experimenter's laboratory data conducted as part of this research as well as that of others is provided to substantiate the fact that replication of the experimental conditions which are favorable to initiating and sustaining the new energy release process will generate controllable, reproducible, sustainable and commercially meaningful heat. By the end of the thesis the reader will have substantial information to draw a conclusion for themselves as to the potential of BLP technology to achieve commercialization and become a new energy paradigm for the next century.





THIS PAGE BLANK (USPTO)





Peter Mark Jansson, P.P.,P.E. Mini-Abstract

MINI-ABSTRACT

Peter Mark Jansson, P.P., P.E.

HYDROCATALYSIS: A NEW ENERGY PARADIGM FOR THE 21st CENTURY

May 1997

Dr. John L.Schmalzel, P.E. - Thesis Advisor Graduate Engineering Department

This thesis reviews the technologies used worldwide to meet the energy needs of our industrial societies. This work also describes a new technology being developed by BlackLight Power, Inc. [BLP] of Malvern, Pennsylvania. Laboratory data of the author as well as that of other scientists substantiates that the new BLP energy release process generates sustainable, commercially meaningful heat.





THIS PAGE BLANK (USPTO)





Peter Mark Jansson, P.P., P.E. Page 1 of 73

<u>HYDROCATALYSIS:</u> A New Energy Paradigm for the 21st Century

Introduction and Thesis Overview

This thesis will review the problems of worldwide energy supply, describe the current technologies that meet the energy needs of our industrial societies, summarize the environmental impacts of those fuels and technologies and their increased use by a growing global and increasingly technical economy. After reviewing both the renewable and non-renewable options we have as a society, this work will describe and advance the technology being developed by BlackLight Power, Inc. [BLP], a scientific company located in Malvern, Pennsylvania. BLP's technology proports to offer commercially viable and useful heat generation via a previously unrecognized natural phenomenon - the catalytic reduction of hydrogen to a lower energy state. This reduction of hydrogen to fractional quantum energy levels is based upon a radical modification to the theoretical hydrogen atom energy equation developed by E. Schrödinger and W. Heisenberg in 1926. Dr. Randell Mills of BLP has proposed that a new boundary condition, derived from Maxwell's equations, be applied to that fundamental hydrogen equation. Dr. Mills' model then would suggest a purely physical model of particles, atoms, molecules and overall cosmology. His mathematical solutions contain fundamental constants only and energy values predicted by his theoretical approach agree in a most compelling way with observations scientists have made of the universe and stars.

This source of energy is proported to comprise a significant portion of the radiant energy created by stars. The new form of hydrogen atoms with their electrons below the current "ground" state have been named "hydrinos" by their discoverer, Dr. Mills. BLP scientists believe it is this matter that comprises the significant part of the dark matter of space. It will not be the attempt of this engineering thesis to debate the merits of Dr. Mills' theory in this regard but rather to review and sometimes replicate the scientific calculations and supporting data which indicate the merits of the existence of hydrinos. This thesis will also review this experimenter's laboratory data as well as that of others that substantiates the fact that replication of the experimental conditions which are favorable to initiating and sustaining the new disproportionation process will generate controllable, reproducible, sustainable and commercially meaningful heat. It will describe the technologies currently used in the disproportionation reaction, report on the state-of-the-art for the BLP technology and state the author's opinion as to this technology's potential for successfully addressing [or solving] some of the global energy issues above. [environmental degradation from growing energy use, limits to energy supply at forecasted growth rates, etc.]





THIS PAGE BLANK (USPTO)





Peter Mark Jansson, P.P.,P.E. Page 3 of 73

use coal for heating as well as wind and water power for grinding grains [26,000 kcal daily per capita - 30.2 kWh]. During the Industrial age of the 19th century we added the steam engine as a source of mechanical energy and increased the use of fuel energy in homes for lighting and heating [77,000 kcal daily per capita - 89.3 kWh]. Modern technological society uses the internal combustion engine for transportation, electricity for appliances and comfort which find their energy source in fossil, hydro and nuclear fuels which power steam turbines, furnaces and generators [230,000 kcal daily per capita - 266.8 kWh daily per capita]. [2] This trend indicates that as we improve the quality of life for society a commensurate increase in direct and indirect energy use is requisite. World energy and economic statistics today also demonstrate that there is a direct correlation between a nation's gross national product [GNP] and its energy consumption. The countries of Ethiopia, Mali, Malawi and Niger all have GNPs less than \$250 per capita while energy use is less than 0.4 barrels of oil per capita per year [680 kWh/year]. In contrast, the U.S., Norway, Canada and Sweden are leading economic nations with over \$10,000 of GNP per capita. They use in excess of 40 barrels of oil per capita per year [68,000 kWh].^[3] This one hundredfold increase in energy use is not a coincidence. It is characteristic of a steady evolution of society from a primitive [2.3 kWh] to technological [266.8 kWh] level of advancement and is illustrative of the critical role energy plays in increasing societal maturity, quality of life and productivity.

The sections which follow illustrate the fuels, technologies and methods used around the world to sustain this societal evolution and summarize limits on these elements which must be addressed in order to avoid major problems as the now developing nations [where over 3/4 of the world's population resides] strive to achieve western standards of living through industrialization. Table 1.1 below summarizes the current levels of energy use in the world and U.S. as of 1995.

TABLE 1.1 - 1995 Energy Use by Fuel Type (in trillions of kilowatthours)

Energy Sour	ce	World	U.S.	U.S. % of World
Fossil Fuels	Natural Gas	22.7	6.6	29.2 %
russii i ueis	Petroleum	39.5	10.1	25.5 %
	Coal	26.8	6.1	22.9 %
Nuclear	Fission	7.1	2.2	30.3 %
Nuclear Solar	Hydro Electric	2.5	0.3	10.6 %
TOTAL		98.8	25.3	25.6 %





Peter Mark Jansson, P.P.,P.E. Page 4 of 73

It is important to note that only commercially traded fuels are included in the summary data. The overview provided in Chapter 1 of this thesis presents the energy sources in an order prioritized by the contributions these sources make to industrialized society today.

Chapter 1 - Alternate Technology Overview

Prior to the announcement of the hydrocatalysis process being put forth by BlackLight Power there were fundamentally only five known sources of energy. In addition to the most commonly exploited, fossil fuels, there are nuclear [both fission and fusion], solar [in its many forms], geothermal and tidal. Table 1.2 below briefly summarizes the major energy sources available in our society.

TABLE 1.2 - Energy Sources and Technologies

Energy Source	Fuel Type	Technologies in Use
Fossil Fuels	Natural Gas Petroleum Coal Shale Oil Tar Sands	Heaters, Furnaces, Boilers, etc. Heaters, Furnaces, Boilers, etc. Heaters, Furnaces, Boilers, etc. Processing facility yields petroleum Processing facility yields petroleum
Nuclear [Fission]	Uranium	PWR creates steam / electricity BWR creates steam / electricity Breeder technology - LMFBR
	Plutonium	No Technology Exists as of Yet
Nuclear [Fusion]	Hydrogen	Passive & Active Water Htg. Systems
Solar	Solar Thermal	Passive & Active Space Htg. Systems Power Tower/Parabolic Dishes / Trough
	Photovoltaic	Arnorphous Cells Crystalline Cells [single, multi, etc.]
	Biomass	Wood, Seaweed, algae, etc. Agricultural Crops [alcohol, waste, etc.] Municipal Solid Waste [paper primarily]
	Hydroelectric	Reservoirs, dams, water wheels, generators, pumped storage
	Wind Power	Wind Mills, Sailing, Turbines [VAHA]
	Ocean Waves	Pilot Systems - Compressor/Generator
·	Ocean Thermal	OTEC Design [1930, 1975]
Geothermal	Geopressured Hot Dry Rock formations Hot Water Res. Normal Grad. Res. Natural Steam Molten Magma	Heaters, Turbine/generators Heaters, Turbine/generators Water and Space Htg. Systems Heaters, Turbine/generators Heaters, Turbine/generators No Technology Exists as of Yet
Tidal	Potential Energy of Earth-Moon-Sun gravity	Reservoirs, dams, generators
Hydrocatalysis	Binding Energy of Hydrogen Atom [p* to e* relationship]	Disproportionation Furnace





Peter Mark Jansson, P.P.,P.E. Page 5 of 73

For each energy source the types of fuels used and the technologies in use today which convert those fuels into useful work and energy for humans is highlighted.

1.1 Fossil Fuels

In the United States fossil fuels provide 89.2% of the energy we consume. In 1995 this consisted of a combined consumption of coal equivalent to 787 million tons per year, natural gas of about 22 trillion cubic feet per year and petroleum product use of 5.9 billion barrels per year. It is clear that an industrial society like ours could not continue without these resources. Globally in 1995 our societies consumed 3441 million tons per year of coal, 75 trillion cubic feet per year of natural gas and 23.3 billion barrels per year of petroleum. The U.S. was the leader in the global use of fossil fuels [specifically petroleum] from the very beginning of its industrialization with the oil strike of Edwin L. Drake in Titusville, Pennsylvania in 1859. "By 1909, when the industry was just 50 years old, the United States was producing 500,000 barrels a day, which was more than was produced by all the other countries combined." We remained dominant in the petroleum production and manufacturing markets through 1950 when we still produced over 50% of the world's supply. The key reactions for each of the fundamental fossil fuel types are shown below in Table 1.3.

TABLE 1.3 - Energy Release Processes for Fossil Fuels

Fossil Fuel Type	Chemical Reaction[s]	By- Products
Natural Gas 85% Methane[CH ₄] 15% Ethane[C ₂ H ₆]	$CH_4 + 2O_2 \rightarrow CO_2 + 2(H_2O)$	CO ₂ , CO, water, hydrocarbons and heat [exothermic reaction]
Bottled Gas Propane [C ₃ H ₈] Butane [C ₄ H ₁₀]	$2C_3H_8 + 9O_2 \rightarrow 4CO_2 + 2CO + 8(H_2O)$	CO ₂ ,CO, water, hydrocarbons and heat [exothermic reaction]
Petroleum Gasoline Pentane[C ₅ H ₁₂] Hexane [C ₆ H ₁₄] Heptane[C ₇ H ₁₆] Octane [C ₈ H ₁₈]	$C_8H_{18} + 12O_2 \rightarrow 7CO_2 + CO + 9(H_2O)$	CO ₂ ,CO, water, hydrocarbons and heat [exothermic reaction]
Coal contains carbon plus impurities	$C + O_2 \rightarrow CO_2 + CO$ $S + O_2 \rightarrow SO_2$ [plus SO_x] $N + O_2 \rightarrow NO_2$ [plus NO_1, NO_3, NO_x]	CO ₂ ,CO, SO ₂ , NO ₂ , water, hydrocarbons, SO _x , NO _x particulates, etc. and heat [exothermic reaction]





Peter Mark Jansson, P.P., P.E. Page 6 of 73

It is important to note at this point that all fossil fuels release their energy to man through the chemical reduction process known as oxidation. In this reaction the energy that has been stored in carbon and hydrocarbon chains created during the early history of the earth [250-500 million years ago] is released. In this chemical reaction oxygen combines with the carbon fuel in the presence of heat to release additional heat and form water, carbon-dioxide as well as a host of other hydrocarbons and by-products.

The impact on the environment of the use of the stored chemical energy provided in fossil fuels is significant. "One example is the added burden of carbon dioxide in the earth's atmosphere, with its corresponding potential for modifying the world's climate. Other examples . . . include the acidification of the atmosphere and surface waters, . . . early deaths of thousands by sulfur dioxide in the air, ... ozone formation, ... problems of coal mining, ... acid drainage, ... carbon monoxide and other pollutants from auto traffic, ... thermal pollution of rivers and lakes". [7] We must add to those impacts the environmental degradation to the air, water and soil that is caused by the release of large quantities of these direct pollutants and the other heavy metals and radioactive elements stored by nature in these fuels [lead, mercury, etc.] It was not until the burning of fossil fuels during the 19th century that the element lead began being deposited in regions as remote as the arctic and continent of Antarctica. Many scientists believe that the acidification and resulting "deaths" of many high altitude lakes have been caused by the release of the pollutants generated by fossil fuel combustion [by industry, homes and in automobiles]. The increased sulfur dioxides and nitrogen oxides generated by industrialization are present in the atmosphere and lead to "the formation of acids, primarily H2SO4 and HNO3, from these pollutants and the resulting damage caused by the acidic rain formed is a story of growing importance." [8] Presently the latest environmental alarm sounded has been that of global warming, a proported warming crisis attributable to a significant increase in the presence of so-called greenhouse gases. The earth's surface radiates thermal energy in the infrared region [approximate wavelengths of 4 to 20 μm] which keeps the global environment cooling at a steady rate. Carbon dioxide [CO₂], methane [CH₄] and nitrous oxide [N₂O] represent molecules formed by the use and manufacture of fossil fuels which trap heat at the above wavelengths, heat that would otherwise be radiated from the earth into space. "Carbon dioxide now accounts for about two-thirds of the greenhouse effect, methane about 25%." [9] These environmental impacts caused by growing fossil fuel use are forcing many nations to rethink the role these fuels will play in the future.

The limited amount of fossil fuel resources poses a second major risk to continued expansion of the global economy. At present rates of consumption these fuels only have a limited remaining supply, on the order of decades for a few of them to less than a century in the case of coal. [See Table 1.4] In order to meet the needs of our increasingly advancing and growing societies we must find alternatives. Additionally we must preserve some of these fuels since they also serve as key chemical stores in many critical manufacturing and medicine roles in industrial society. If we conservatively grow the current rates of fossil





Peter Mark Jansson, P.P., P.E. Page 7 of 73

fuel consumption for the energy sector to include the demands that will likely be placed on the finite supply by the developing nations as the globalization megatrend continues we find that the lifetimes are much shorter still.

TABLE 1.4 - Fossil Fuel Reserves and Resource Lifetimes

Fossil Fuel Type	Proven Reserves*	Est. Remaining Lifetime**
<i>Oil</i> Global U.S.	999 x 10 ⁹ bbl 72 x 10 ⁹ bbl	40 years 16 years ***
Natural Gas Global U.S.	5185 x 10 ¹² ft ³ 600 x 10 ¹² ft ³	60 years 20 years
Coal Global U.S.	7.64 x 10 ¹² tonne 1.5 x 10 ¹² tonne	200 years 86 years, 66 years ****

^{*} Remaining as of 1990

As the limits to the fuel reserves in Table 1.4 are approached the price of energy will begin to climb steadily. It is important to note that one of the key drivers to economic expansion is the readily available supply of affordable energy. Already we see a migration of industry in this country moving from the high-energy cost areas [Northeast and California] to the more inexpensive energy cost areas of the Northwest and Southern states. Many industries which were energy intensive have left the service area of Atlantic Energy [southern New Jersey] to move south over the past decade to North Carolina or another lower energy cost state for primarily energy reasons. [NOTE: economics has played the major role in corporate decisions to relocate from Atlantic Energy's region including costs associated with energy, taxes, employment and environmental compliance] We can estimate that on a global scale the trend will be the same, manufacturing [and the associated benefits of its economic engine] will move to where energy, overall manufacturing and labor costs can keep the company competitive. As industry and manufacturing leave the U.S. for less developed nations the commensurate growth in energy demand and desire for a higher standard of living on the part of those nations' workforces will all press the global

At current consumption rates

Since 1948 the U.S. has imported more oil than it has exported. In 1984 the U.S. was importing 50% of its needs At current consumption rate increased by 5% per year, if coal fills all U.S. energy needs when other fuels deplete





Peter Mark Jansson, P.P.,P.E. Page 8 of 73

energy reserves via higher growth rates in consumption. Examples of this include the nations of Indonesia, Malaysia, Thailand and Vietnam where the annual growth in electricity demand has become double digit during the last 10 years. Were the nations of the developing world [China, India, Southeast Asia, Africa] to develop an energy appetite just a fraction as great as their technologically advanced sister countries [U.S., Canada, Japan, Norway, Sweden] the pressure on the limited global reserves and the strain on the atmosphere would become severe.

This researcher estimates that the values in Table 1.4 for the expected remaining lifetime of global fossil fuel reserves can be reduced by as much as a factor of 2 if the trend in third world energy development follows the forecasts outlined by the World Bank. As these pressures on conventional fuels drive price upward shale oil and tar sand reserves as well as many enhanced oil recovery technologies will become more economic.

An excellent illustration of the demands placed on energy by a developing, industrializing society is illustrated by the following two figures. Figure 1.1 demonstrates the relationship between energy consumption and economic activity based upon figures developed in a Scientific American article in 1971. Figure 1.2 develops similar data on per capita gross national product vs. annual energy consumption based upon World Bank data in 1987.[11] If one observes the nation of Japan on both figures and considers the position it had in the global economy in the early 1970s contrasting it with the economic powerhouse it was becoming by the late 1980s we can see the increase in energy demand that was placed upon the global energy market in order to sustain that one country's economic advancement. Japan's population in 1961 was 89.2 million^[12] and it grew to 119.5 million in 1983. In 1971 Japan's populus consumed approximately 33 x 10⁶ Btus per capita [9,669 kWh] annually. In the short 16 years of their continued economic growth between 1971 and 1987 their energy use per capita grew to 22 barrels of oil [37,400 kWh] annually. This represents a 4 fold increase in per capita consumption and a 5 fold increase in overall national energy consumption [based upon a 1971 population of 103M and a 1987 population of 125M]. This energy growth correlates directly with their GNP growth from \$550 US [1971] to \$12,000 US [1987] and the extensive industrialization of their economy. Japan's energy consumption now is 43,285 kwh per capita [1995] and while it continues to grow, their population remains steady at 125M. Were a single, large developing nation such as India [population 936M in 1995] to undertake an economic expansion similar to Japan the impact on global fossil fuel markets would be substantial. India's per capita energy consumption in 1995 was 2,563 kWh annually, were they to reach Japan's per capita energy use it would represent a 17 fold increase in their energy use. By 2020 they would become a nation that consumes 5.7 x 10¹³ kWh annually [assumes continued current population growth rate and acheivement of Japan's level of industrialization and commensurate per capita energy usage]. India's one year energy use in that year would represent 64% of the entire World's energy consumption in 1995 [see Table 1.1]. At those usage rates that one nation alone could consume the entire world's remaining supply of oil

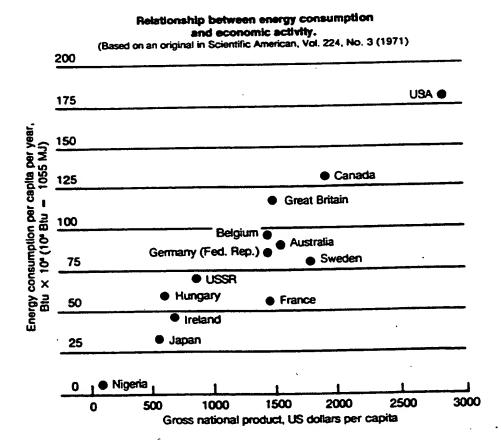




Peter Mark Jansson, P.P., P.E. Page 9 of 73

in less than 30 years. In aggregate, the developed nations' growing energy consumption rates combined with their continued population growth will substantially reduce the estimates of fossil fuels' expected remaining lifetimes from those shown in Table 1.4. "There is no escaping the reality... fossil fuels are formed over very long time periods, and although some new deposits will certainly be discovered, there will be no significant increases in the world inventory over human history... the era in which we live is extraordinarily specialized and is set off from all human history and future on this planet by our use of fossil fuels. These energy resources were laid down over hundreds of millions of years during the earth's evolution, and they are now being consumed in what is essentially an instant in our occupation of the planet." Without the discovery and development of an environmentally friendly, inexpensive energy source to significantly offset the consumption of these ancient energy reserves, we will enter the new millennium only to quickly find that the standard of living developed by western civilization is not a sustainable one.

FIGURE 1.1





Peter Mark Jansson, P.P.,P.E. Page 10 of 73

FIGURE 1.2 Per Capita GNP vs. Per Capita Energy Consumption

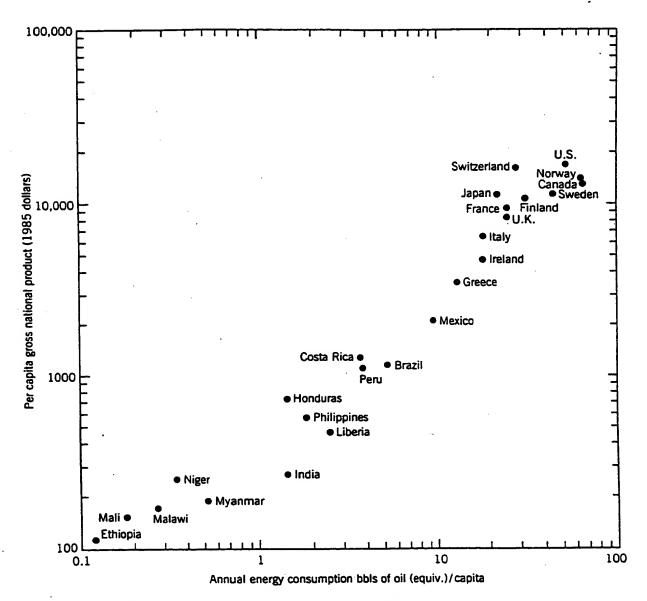


Figure 1.15 Per capita gross national product in 1985 dollars and per capita energy consumption per year in terms of the equivalent barrels of oil. (Source: World Bank [1987]. Adapted from E. S. Cassedy and P. Z. Grossman Introduction to Energy, resources technology and society. Cambridge: Cambridge University Press [1990].)



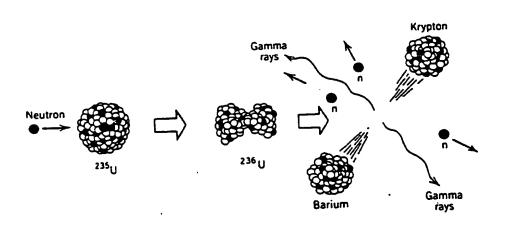


Peter Mark Jansson, P.P., P.E. Page 11 of 73

1.2 Nuclear Energy - Fission and Fusion

While the fissionability of uranium was first discovered in 1938 it was not until Enrico Fermi constructed a sustainable nuclear reactor in 1942 that the usefulness of this technology for energy production was truly demonstrated. In a parallel way in which chemical [electronic] bonds between carbon atoms are broken down through chemical combustion with oxygen, the breaking of nuclear bonds via a fission reaction is caused by the bombardment of a radioactive uranium atom's nucleus with neutrons. This bombardment, upon successful collision, causes the nucleus of the uranium atom [235 U] to become a highly excited uranium atom [236 U], this atom rapidly separates [or fissions] into smaller pieces forming new nuclei as a result. This is more clearly illustrated in Figure 1.3 below. The energy released via this nuclear reaction is equal to Einstein's famous equation $E = mc^2$. To put this in perspective, the energy available within a ton of coal that is chemically released through combustion [ie; breaking down all of the carbon bonds] is 7056 kWh. Were that same ton of coal to be converted to energy via a nuclear reaction the energy available is 22.7 trillion kWh, this is 3.2 billion times more energy.

FIGURE 1.3 Neutron Induced Fission of ²³⁵U



This process of working on the nuclear bonds of the atom, rather than the chemical bonds of molecules releases a significant amount of the nuclear binding energy within the atom. What makes this a sustainable chain reaction is the creation of additional neutrons [see fission reaction in Table 1.5] from the fission reaction which can then go and impact additional uranium nuclei to keep the bombardment occurring without external neutron input. Control rods used in commercial nuclear power plants provide a moderating effect





Peter Mark Jansson, P.P., P.E. Page 12 of 73

on the reaction by absorbing excess neutrons in order to slow or to bring the reaction to a stop. The process outlined above is used in both pressurized water reactors [PWR] used significantly in nuclear submarines and power plants as well as in boiling water reactors [BWR] used widely for commercial applications.

TABLE 1.5 - Energy Release Processes for Nuclear Fuels

	•	
Nuclear Process	Nuclear Chain Reaction[s]	Energy Release
Fission	$n + {}^{235}U_{143} \longrightarrow {}^{236}U_{144} \longrightarrow {}^{144}Ba_{88} + {}^{89}Kr_{53} + 3n$	+ 177 MeV
Breeder	n + ²³⁸ U -> ²³⁹ U -> ²³⁹ Np -> ²³⁹ Pu + >1n	+ 177 MeV
Fusion	$^{1}H_{0} + ^{1}H_{0} \longrightarrow ^{2}H_{1} + \beta^{+} + \nu + \text{energy}$ (1) $^{1}H_{0} + ^{2}H_{1} \longrightarrow ^{3}He_{1} + \text{energy}$ (2) $^{3}He_{1} + ^{3}He_{1} \longrightarrow ^{4}He_{2} + 2^{1}H_{0} + \text{energy}$ (3) $^{4}H_{0} \longrightarrow ^{4}He_{2} + 2\beta^{+} + 2\nu + \text{energy}$	

Detailed descriptions of the nuclear energy process is not within the scope of this research but rather an overview of these technologies and their associated economic and environmental risks are described below.

The breeder reactor is a concept not yet fully commercialized which takes advantage of the fact that free neutrons are not only capable of inducing fission via a conversion of ²³⁵U to ²³⁶U, but are also as equally capable of converting a ²³⁹U atom into ²³⁹Pu. This is very valuable since ²³⁹Pu is also a fissionable material capable of acting as a fuel in standard nuclear reactors. If the design of a breeder reactor could be optimized to create additional ²³⁹Pu while also creating uranium fission it would be a reactor that created its own fuel and would significantly increase the lifetime of nuclear fuel materials.

Fusion is a nuclear reaction that occurs commonly on the stars and in the case of our sun is likely the source of approximately 60% of the energy it provides. This estimate is based upon observed solar neutrino flux as measured by the Gallex solar neutrino detector in Italy. ^[15] As shown in Table 1.5 above according to the Standard Solar Model fusion begins with the combining of two hydrogen nuclei (protons) to form a deuterium nucleus. The process then continues to build a heavier helium nucleus all the while releasing large amounts of the nuclear binding forces within the atom. For a more complete explanation of this process the reader is referred to pages 108-111 of "Energy and Problems of a Technical Society" ^[16], which is an excellent summary of energy technology information





Peter Mark Jansson, P.P.,P.E. Page 13 of 73

referred to often in this paper. Due to the very high temperatures involved, the limits of current materials and the fact that proof of the scientific feasibility of the essential reactions has not yet been established it is unlikely that significant additional funding will go into the development of fusion. The Tokamak Fusion Test Reactor [TFTR] located at the Princeton University Plasma Physics Lab was designed to answer some of these fundamental questions. It appears that after significant resources have been invested in this test those questions will still not be sufficiently addressed. The TFTR was shut down on April 3, 1997 "many say prematurely ... for lack of money" [17]

In the U.S. during the last decade no new nuclear power facilities have been opened, ordered or planned. This is due in large part to 4 primary developments during the past 15 years. These facilities have become very expensive to build and meet all Nuclear Regulatory Commission [NRC] standards, the issue of nuclear waste storage has yet to be resolved by the utilities and the Federal government, there was and continues to be significant public opposition to this technology and there have been key nuclear accidents which have increased the financial risks and liabilities to investors and owner / operators of such facilities. When nuclear advocates were espousing the virtues of this technology in the 1960's and 1970's it was believed that the energy would be so cheap that utilities would not need to meter customers any longer. As the technology was deployed, many safety features were required "along the way" by the emerging NRC which wanted to assure the safety of the technology. This often led to major cost overruns and units that were intended to come on line for \$1,000 - 1,500 per kilowatt escalated to often over \$4,000 per kilowatt. Many units in the Northeastern and Western regions of the U.S. were never finished due to these massive costs. This is clearly one of the key reasons utilities are not interested in the technology today. Another reason is the longevity of hazardous nuclear radioactive wastes. Table 1.6 below indicates the lifetimes of radioactive materials generated as by-products from the nuclear industry.

TABLE 1.6 - Nuclear Fission By-Products Radioactive Halflives^[15]

Radionuclid e	T _{1/2} [Halflife]	Decay Particle
²³³ U [uranium-232]	1.59 x 10 ⁹ years	α
²³⁹ Pu [plutonium-239]	2.41 x 10 ⁴ years	α
³ H ₂ [hydrogen-3, tritium]	12.35 years	β
⁹⁰ Sr [strontium-90]	29 years	β
131 [iodine-131]	8.04 days	β
137 Cs [cesium-137]	30.17 years	β
85 Kr [krypton-85]	10.72 years	β





Peter Mark Jansson, P.P.,P.E. Page 14 of 73

It is clear that wastes from the nuclear industry will need to kept away from the human population and environment for excessive lengths of time [often exceeding many generations]. Although this was known in the early years of this technology, as of today, after over 20 years as an active industry, the government and utilities have yet to find an acceptable long-term high level waste repository. It is unlikely that the nuclear industry in the U.S. will see any significant expansion during the next few decades. In Sweden recently the government ratified its 17 year old promise to remove all nuclear reactors from service in its country by 2010. The first two reactors will be officially removed from service in 1998 and 2001 "before their technical life expires". ^[19] This leaves only France, Japan and a few developing nations that will be expanding their commitments to nuclear fission as a viable energy source for the future.

1.3 Solar Energy

Without a doubt the most widespread form of energy in the universe is the energy radiated from the stars. Specifically in our solar system, the Sun is the source of nearly all forms of useful energy. From the fossil fuels first formed by carbon fixing organisms [plants and animals] in the presence of solar energy 250-500 million years ago to the hydroelectric plants operating on major rivers, the Sun is responsible for creating the potential energy each represents. This section will briefly summarize all of the primary forms of solar energy and prioritize their discussion from the most economical and technologically ready to the forms that are the least economical and require the most additional development. It is important to note that although significant attention is given to these sources of energy because of their potential for the future, at the present time solar energy in all of its forms represents less than 3% of the World's commercially traded forms of useful energy. Of that small fraction over 90% represents the use of solar energy in the form of hydropower.

The most developed form of solar energy is hydroelectricity. The hydrologic cycle driven by the sun evaporates over 5.5 quadrillion cubic feet of water from the earth every year. This same energy falls back to the earth in the form of rain and the potential energy of water at higher elevations. Of the more than 100 quadrillion kilowatthours of energy in the hydrologic cycle only a very small portion is harnessable. Most precipitation falls back into the oceans with only a fractional amount falling upon dry land at higher elevations where its potential energy becomes available for exploitation via rivers, dams, waterwheels and hydroelectric generating facilities. World energy usage statistics indicate that in 1995 we were providing approximately 2.3 trillion kilowatthours of our global society's energy needs through hydroelectric sources. This represents approximately 2.5% of all energy consumed. Man's use of falling water to displace human and animal energy dates back over 2000 years. Hydropower also played a major role in the industrialization of western





Peter Mark Jansson, P.P.,P.E. Page 15 of 73

Europe the 16th century when waterwheels served as the primary powerhouses. While many believe the potential for exploiting more hydropower is great there are environmental considerations and social concerns that make extensive expansion unlikely. Due to the need to create large dams and reservoirs to harness hydropower there is often substantial displacement of people as well as restriction of the normal ecology of the river. While it represents a significant capital investment, where it can be practically developed hydropower remains an economic source of electricity.

The most widely known and experienced form of solar energy is biomass. A significant majority of the World's now 5.8 billion people [21] come in contact with this fuel on a daily basis. The biomass category represents fuelwood, charcoal, agricultural products and waste [alcohol, dung, mill residues, rice hulls, straw, etc.] as well as the less recognized biomass of industrial society - municipal solid waste [mostly paper and packaging materials]. Least recognized in the category of biomass is the harvesting of ocean biologic life [seaweed, algae, etc.] for fuel production. "Noncommercial biomass fuels ... already supply more than 10 percent of total global energy needs and a much higher percentage of the energy needs in developing nations, albeit with low levels of efficiency and service quality." This source does not appear in Table 1.1 since very little biomass is commercially traded on the global level. The sun plays the critical role in the creation all the biomass fuels either directly through photosynthesis or indirectly via man's or animal's use of a product the sun's energy created [ie; foodstuffs, paper, etc.]. Besides using biomass for meeting heating and other human energy needs probably the most common use is in the food we eat. Vegetables, fruits and other animals all received their energy from the solar source as well through the process of photosynthesis shown below:

$$6CO_2 + 6H_2O \xrightarrow{\text{LIGHT}} C_6H_{12}O_6 + 6O_2$$

The energy release processes for biomass are very similar to fossil fuels where the biomass is directly burned in the presence of oxygen to release the energy of carbon chains and form CO₂, H₂O, etc. Continued use of biomass is inevitable, expanded use of wood and woodwaste as a fuel in the U.S. is likely as well. Without specialized biomass growing and harvesting techniques and efficient fuel conversion systems it will be quite a few years into the future before these fuels will become economic on a large scale and find a major place in the growing global energy market. The energy densities of biomass fuels are relatively low, on the order of lignite to peat coal resources, and this also presents barriers to commercial development.

Another widely experienced form of solar energy is the direct heating of the sun known as solar thermal energy. From the highly technological systems we have created [passive and active solar space and water heating systems] to the primitive habit of laying out in the sun for a siesta or tan, the human race daily takes advantage of the direct warming





Peter Mark Jansson, P.P.,P.E. Page 16 of 73

available from the sun. Many societies still use the sun for drying grains [such as rice] as a critical step in their agricultural process. In the U.S. the most prevalent form of solar thermal energy use is in passive and active heating systems for homes as well as heating systems for hot water. During the late 1970s and early 1980s the Federal government provided significant tax incentives for renewable energy systems. This led to many domestic solar hot water heating systems being installed throughout the country. These systems typically consist of a solar collector device that traps incoming short wavelength incident solar radiation and upon collision with a dark, metallic 'absorber' plate the light energy is converted directly to heat [or mechanical molecular vibrational energy] in the absorber plate. This collector is typically called a flat-plate solar collector. The absorber plate typically has an antifreeze solution which runs through it [i.e. it acts as a heat exchanger to move the incoming solar energy it absorbs into the fluid] and this fluid is used to capture, move and store the solar energy for use either in a hot water system or for heating a home or building. Another example of solar thermal energy systems is the focusing collector which comes in various shapes, sizes and configurations. From the Solar One power tower demonstration in Barstow, California which had a commercial production of 10 megawatts, to modular, parabolic dish and trough systems that collect watts to kilowatts of power, directly focusing the sun's energy on a light-absorbing surface can create commercially meaningful heat. The drawbacks with all of these systems was that they were never economically attractive. Most solar thermal heating systems have between a 15 and 30 year simple economic payback. Without significant social policy change or government subsidy these types of heating and energy production systems will not be commercially significant.

Another solar resource is wind power. In 1995 it was estimated that geothermal, wind and solar of all types accounted for nearly 5% of the world's primary electricity generation [ie; 0.5% of the world's total energy resources]. This resource was used from the most ancient of times by mariners in their quest for increasing the speed of their then human powered vessels to the applications of water pumping and grain grinding by animals in Europe and America in the 19th and 20th centuries. Wind power is still used in many locations throughout the world for these purposes. As an electricity generating source wind power first began to find its way into the marketplace in the 1970s and 1980s in both Europe and the U.S. While we know that the mechanical motion of air is a direct consequence of solar heating of the planet it has always been a challenge to economically extract the energy in this air movement. Modern wind turbines are designed to remove the kinetic energy in the wind and use that energy to turn a generator to provide electricity. They do this by placing their aerodynamically efficient blades into the wind to enable the mechanical force of the wind to cause those blades to rotate and sweep over a large area. Present technologies include vertical axis wind turbines as well as horizontal axis wind turbines; manufacturing is dominated by the latter at the present. The energy that can be removed by a wind turbine is proportional to the area its blades sweep out as well as the cube of the wind velocity. For this reason most turbines are mounted on towers to place

1





Peter Mark Jansson, P.P.,P.E. Page 17 of 73

them more aloft where higher wind regimes are present. In areas of moderate to high annual wind speed, wind turbine generators are able to create electricity at approximately \$.05 per kWh assuming a 20 year equipment life. It is difficult to find areas where local citizens are willing to allow wind facilities to be located at the present time and it is also increasingly difficult to find investors willing to tie up their capital for a project that produces electricity at a higher cost than where the electricity market is at present [i.e. \$.02-03 per kWh].

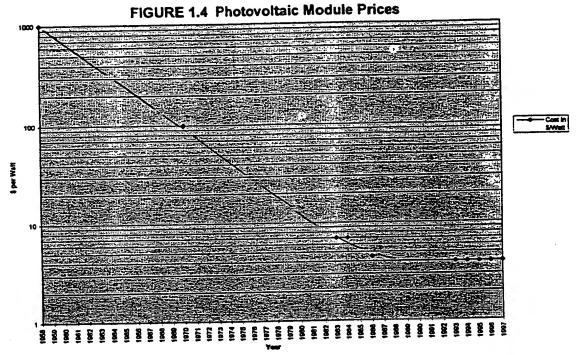
A widely acclaimed technology that showed promise in the 1980s of becoming a major player in the solution to the energy crisis is photovoltaics. These are semiconductor devices made of materials that are designed and oriented in such a way as to convert light energy [photons] directly into electrons at efficiencies of 5-30%. PV devices being developed commercially employ similar physics in their operation. The photovoltaic effect is created when incoming photons interact with electrons in a semiconductor material so as to create a charge carrier pair; an electron and a "hole". Each PV device is constructed with positively and negatively doped layers so as to maximize the cell's ability to separate the charge carriers and keep them separated so as to induce a voltage across the cell as long as the incoming light is present to induce this voltage. The photovoltaic effect was first discovered by 17 year old French physicist Edmund Becquerel in the 1850s when he was experimenting with batteries. He noticed that his batteries were able to provide significantly more energy in the presence of light than when shaded in the darkness. He noted this in his journal but it wasn't until Albert Einstein's work in 1905 that the principles behind the photoelectric effect were described scientifically. This technology's potential lay dormant for another 50 years until the space race began. After Russian scientists launched Sputnik in 1957 and the U.S. had fallen behind in the race they wanted to assure that their first satellite would 'last longer'. As a result in 1958 the Vanguard satelite was launched by the U.S. powered with not only a battery, but a battery recharged on-board by the world's first commercial application of photovoltaic cells. [Sputnik lost its battery energy and floated useless in space after only a few months] Those cells, costing over \$1000 per watt kept the Vanguard satelite's batteries charged for years of successful operation.

Since that time the cost of photovoltaic [called PV] cells continued to plummet driven by advances in technology, increased manufacturing volume and increasing demand for satellite applications, remote power applications as well as commercial electricity uses. Figure 1.4 shows the progressive decline in PV cell prices as advances in technology continued through the 1980s. By the late 1980s as Federal research monies for renewables decreased during the Republican Administration, the commensurate investment in and advancement of PV technology subsided. Current pricing for PV cells has not substantially changed from those present in 1989





Peter Mark Jansson, P.P.,P.E. Page 18 of 73



In addition to the photovoltaic modules that are made up of cells configured to provide adequate current and voltage, a PV system requires balance of system components. These components are module mounting and wiring peripherals, a DC to AC inverter for typical interface with home wiring and the installation [roof or ground mount, etc.] of the entire system. In 1996 these were estimated to cost \$2 per watt, \$1 per watt for the inverter and \$1 per watt for balance of system hardware and installation. This would bring a total PV system's cost to \$6-7 per watt installed. To put this in perspective, a typical home could use a 4kW system which cost \$24,000 to install. This system would provide approximately 6,000 kilowatthours of useful energy each year at present electricty rates this \$750 per year savings represents a simple payback of 32 years. Near term growth in economic expansion of the PV market for utility connected customers appears unlikely. Market research conducted by the author and his colleague indicate that until installed PV prices reach \$0.6-1.3 per watt, no major changes in the demand for PV by the grid-connected market is likely. [23] There are many different types of PV cells that have been attempted from single crystalline to multi crystalline to amorphous cells. In the last five years only minor additional improvements to the technologies have been made leading to a flattening of the price curve at \$4 per watt since 1990 [see Figure 1.4].

Probably the forms of solar energy with the least potential for future development and expansion are ocean thermal and wave power. The ocean is a source and sink for energy of many types. It is probably the vast dihydrogen oxide resource of the ocean that





Peter Mark Jansson, P.P., P.E. Page 19 of 73

keeps the temperature, environment and atmosphere of the planet moderated and suitable for human life. In that same environment thermal gradients and atmospheric disturbances cause currents, waves and temperature differences around the world. Ocean Thermal Energy Conversion [OTEC], is a technology that was conceived of in 1880 by d'Arsonval. OTEC takes advantage of the thermal gradient which exists in the sea and is especially pronounced around the tropical regions where surface water temperatures can get very high. This approach to energy generation uses ammonia as a working fluid. This fluid runs an evaporator-condensor cycle where cold water from deep in the ocean condenses the ammonia vapor while warm water on the ocean surface is used as a heat source to boil the ammonia to give it the vapor pressure needed to drive a gas turbine. The gas turbine in turn drives an electric generator. In 1930 the first demonstration plant was constructed in Cuba; since that time no additional plants or demonstrations have been constructed. The islands in the tropic zones may have potential for this technology at some point in the future but presently the technology is very expensive which has limited its development. Wave energy systems are not commercially available at the present, but it is believed that the difference in wave heights may be commercially exploited at some point in the future. Ocean currents may provide a significant potential source of energy as well but no commercial technologies currently exist to harness it effectively. Similarly to OTEC, ocean current systems will be further hindered by the fact that where the energy source is located is often far from where the demand for energy exists.

1.4 Geothermal Energy

If you have ever sat or swam in a natural hot spring you are familiar with one of the benefits of Nature's outpourings of geothermal heat. While less dramatic than the volcanos or geysers, low temperature geothermal sources make up a significant portion of the global geothermal resource. The most widely used type of geothermal resource for energy generation is the natural steam reservoirs. By 1990 the U.S. was generating "over 2800 MW_e at 4 to 6 cents per kWh"^[24] from these reservoirs in the western states. While the U.S. potential for geothermal is estimated at 22,675 QBtu [this compares with an annual U.S. energy use of 82 QBtu] there has been little additional exploitation of these reserves since the removal of Federal tax subsidies in the 1980s. The most economical and expanding market for geothermal energy applications exist in the residential and commercial sectors. Geothermal heating and cooling systems use the earth as a heat source and sink with an electric heat pump to move heat into or out of the conditioned space. Geothermal heatpumps move 3-4 kWh of energy for every one kWh of energy they consume. This technology was perfected in Sweden and is seeing extensive application in the U.S. and other industrialized countries. In many applications it represents the least costly heating and cooling system on an annual energy as well as operation and maintenance cost basis. The use of geothermal energy in these applications is likely to expand.





Peter Mark Jansson, P.P., P.E. Page 20 of 73

1.5 Tidal Energy

There are presently no commercial tidal facilities in the United States and only three tidal power systems in the world. These facilities operate on principles that are very similar to those of hydroelectric stations. They require a reservior, a dam and a series of turbine generators. In the case of tidal systems they are capturing the kinetic energy that exists in the movement of tidal waters into and out of an estuary or man-made reservior four times each day. The energy is being created by the gravitational interaction of the Sun, the Moon and the Earth which causes this motion in the seas daily. In the lower 48 continental U.S. the tidal variations range from 2 to 16 feet between mean high and mean low waters. In the U.S. the potential for tidal power represents less than 15,000 MW. The global potential for the most favorable tidal power sites is about 63,000 MW, or about 1/50th the world's potential for hydroelectric power. The three tidal facilities in operation worldwide are a 1-MW plant on the White Sea in Russia [1969], a 240-MW plant on the Rance River in France [1966], and most recently a 20-MW plant on the Bay of Fundy in Canada.





Peter Mark Jansson, P.P., P.E. Page 21 of 73

Chapter 2 - An Overview of Mill's Technology

This chapter will focus specifically on the hydrocatalysis technology developed by Dr. Randell Mills of BlackLight Power, Inc.. After providing an overview of the theory behind the design of the various technologies I will move to a review of the astrophysical data which supports Dr. Mills' claim that fractional state hydrogen is common and abundant throughout the universe. I will highlight some key enigmas that Dr. Mills' theory solves and review the current technological devices that capture energy from this new found fuel source. Table 2.1 below summarizes the significant government, corporate and university research centers that have partnered to corroborate many of BLP's experimental findings.

TABLE 2.1 - BlackLight Power Research Partners

LABORATORY

Government

Idaho National Engineering Laboratory

SDIO-Wright Patterson AFB
Chalk River National Lab [Canada]
NASA - Lewis
Brookhaven National Lab

University

Lehigh University - Zettlemoyer Center for Surface Studies M.I.T. Lincoln Laboratory Pennsylvania State University Ursinus College Moscow Power Engineering Institute Laboratory for Electrochemistry of Renewed Electrode-Solution Interfaces [LEPGER]

Corporate

Thermocore, Inc.
Air Products & Chemicals
Westinghouse Electric Corporation
Charles Evans & Associates Laboratories
Schrader Analytical & Consulting Laboratory
BlackLight Power Laboratories

WORK PERFORMED

Electrolytic Cell [850% VI]
X-ray Photoelectron Spectroscopy
Diffusion Cell
Electrolytic Cell [130% Vi DC]
Electrolytic Cell [170% Vi DC]
Electrolytic Cell

X-ray Photoelectron Spectroscopy

Electrolytic Cell [400% Vi DC]
Gas Cell [>2000% H₂ Energy]
Electrolytic Cell
Electrolytic Cell [250% Vi DC]
Electrolytic Cell

Electrolytic Cell [2100% Vi AC]
Mass Spectroscopy
Electrolytic Cell [150% Vi DC]
TOF-SIMS
Mass Spectroscopy

Electrolytic Cells [2100% Vi AC] Gas Cells [2 - 50 watt Energy] Mass Spectroscopy Gas Chromatography





Peter Mark Jansson, P.P.,P.E. Page 22 of 73

In the column entitled "Work Performed" I have summarized the types of devices tested or work performed in each laboratory. In all cases these labs provided data and results which were consistent with the results anticipated by the Mills theory [i.e. excess heat production, hydrino or dihydrino signatures, etc.]. The numbers in brackets, where provided, show the energy output to energy input ratio confirmed by the lab. I gathered this data by reading and summarizing the reports produced by the labs themselves. A detailed bibliography of the reports generated by these partnerships, plus others I was able to catalogue has been provided in Appendix 1. It is important to note that all of the work in Table 2.1 is very recent, having been completed during the last five years. The four subsections of Chapter 2 are as follows: Section 2.1 will briefly describe the theory Dr. Mills developed leading to the design of the various BLP technologies. Section 2.2 will summarize and analyze some of the astrophysical data which supports Dr. Mills' claims with that this new form of hydrogen is prolific throughout the universe, Section 2.3 will describe a few of the enigmas that Dr. Mills' theory solves, and Section 2.4 will provide a brief synopsis of the state of the art of current BLP technological devices that demonstrate energy production from the new found fuel source.

2.1 Hydrocatalysis - A Theoretical Overview

The catalytic reduction of atomic hydrogen below its ground state of n=1 has been postulated by Dr. Randell Mills of BlackLight Power, Inc. There is substantial data that has been gathered confirming an unexplainable amount of energy being released from hydrogen; these energy values are well in excess of any known chemical reaction with hydrogen and were observed by others when reproducing BLP experiments. In addition, new electronic signatures corresponding to the expected [ie; calculated] energy values for low energy hydrogen via mass spectroscopy, gas chromatography, x-ray photoelectron spectroscopy and extreme ultraviolet spectroscopy have been identified. A non-trivial number of independent laboratories and research centers have been involved in the confirmations described in the above findings. In addition, a sound theoretical basis for the phenomenon has been postulated by Dr. Mills which unifies field theory with a completely classical approach to physics. Mills theory holds at its foundations inviolate the classical laws of physics, including all of those listed below:

- 1] Conservation of mass-energy
- 2] Conservation of Linear and Angular Momentum
- 3] Maxwell's Equations
- 4] Newton's Laws of Mechanics
- 5] Einstein's Special Relativity
- 6 Einstein's General Relativity

The postulated reduction of hydrogen to fractional quantum energy levels represents a radical departure from currently held quantum theory. But when it comes to





Peter Mark Jansson, P.P.,P.E. Page 23 of 73

the classical laws of physics the Mills' theory rather than contradicting current models actually builds upon them. Dr. Mills' approach is fundamentally based upon the theoretical hydrogen atom energy equation developed by E. Schrödinger and W. Heisenberg in 1926 shown below. [26]

$$E_n = -e^2/n^2 8\pi \epsilon_0 a_H = -13.598 \text{eV}/n^2$$
 (1a)

$$n=1,2,3,\ldots \tag{1b}$$

Dr. Mills has proposed that a new boundary condition, derived from Maxwell's equations, be applied to Schrödinger's original equation. When it is applied to the fundamental hydrogen equation the Mills' model suggests a purely physical model which applies for all of known nature. This same model applies on the microscale [i.e. particles, atoms, molecules] and through the macroscale [i.e. planets, stars, galaxies and the overall universe]. A more detailed overview of Mills' theory for the interested reader was developed by this researcher and is provided in Appendix 2. The modification Dr. Mills' theory would make predicts that equation (1b) above be replaced with equation (1c) below which allows for lower than n=1 non-radiative valence states for the hydrogen atom.

$$n = 1, 2, 3, \ldots, and, n = 1/2, 1/3, 1/4, \ldots$$
 (1c)

His mathematical solution uses fundamental constants only and the energy values predicted by his theoretical approach agree in a most compelling way with observations scientists have made of the universe and stars. The new form of fractional valence states of the hydrogen atoms [named "hydrinos" by their discoverer, Dr. Mills] are able to radiate meaningful amounts of energy as they undergo electron relaxation to lower energy states [see Table 2.2].

TABLE 2.2 - Energy Released From Lower Energy Hydrogen

_	R [radius]	Energy Released (eV)		
n	K [radioo]	r=∞ tor=R	$\Delta E_{final} - \Delta E_{initial}$	
4	a .	13.6		
1	а _н а _н /2	54.4	40.8 [1->1/2]	
1/2	a _H /3	122.4	68.0 [1/2->1/3]	
1/3	ан/4 ан/4	217.7	95.3 [1/3 ->1/4]	
1/4	ан/-т ан/5	340.1	122.4 [1/4->1/5]	
1/5		1360	258.4 [1/9->1/10]	
1/10 1/100	а _н /10 а _н /100	136keV	2706.4 [1/99 -> 1/100]	





Peter Mark Jansson, P.P.,P.E. Page 24 of 73

This source of energy likely represents more than 40% of the radiant energy created by stars. Figure 2.1 below is an illustration of the change in radii of the hydrogen atom taken from his text on his theory "The Grand Unified Theory of Classical Quantum Mechanics". The well accepted model [i.e. when a hydrogen atom absorbs a photon and increases the radii between its electron and proton, n=2, n=3, n=4, etc.] is shown in the top half of the page.

FIGURE 2.1 Quantized Sizes of Hydrogen Atoms Effective Nuclear Charge x 27.21 eV; n = 1,2.3+1/3 Absorption of Photon +1/n +1/2 Normal +1 Ground ! State - n3 x 27.21 eV +2 +3 Absorption +4 **Energy Hole** +n 0 +5 0 +6

24





Peter Mark Jansson, P.P., P.E. Page 25 of 73

The radical new model Dr. Mills has proposed [i.e. that there exist stable forms of hydrogen in fractional energy states below the accepted ground state, n=1] with its commensurate fractional radii between the electron and proton [i.e. n=1/2, n=1/3, n=1/4, etc.] are shown on the next page. The model being proposed will hereinafter be referred to as "Mills Theory".

It is important to emphasize at this point that the transistions described are not nuclear. This is a chemical reaction that only effects the binding energy of the hydrogen atom's electron. The fundamental energy release mechanisms in this process are hydrocatalysis and disproportionation. Hydrocatalysis occurs when a hydrogen atom with its electron at its normal ground state or a lower ground state [ie; $n \le 1$] reacts with a catalyst having a net enthalpy of 27 eV. Energy is released per equation (1d). Disproportionation occurs when a lower energy state hydrogen atom [ie; n < 1] collides with another lower energy state hydrogen atom [ie; n < 1] which results in the ionization of one atom [ionization energy is a multiple of 27 eV] and the transition of the electron of the other atom to a stable, lower energy level. Energy is released per equation (1e) when the atom which ionizes has its electron at its n = 1/2 state.

$$E = (1/n_f^2 - 1/n_i^2) \times 13.6 \text{ eV}$$
 (1d)

$$E = (1/n_f^2 - 1/n_i^2) \times 13.6 \text{ eV} - 54.4 \text{ eV}$$
 (1e)

The interested reader is referred to Appendix 2 for more detail on Mills theory.

2.2 Astrophysical Corroboration

The theoretical model proposed by Mills might remain an interesting approach to unifying physics but be written off as a theory of no import were it not for the fact that the laboratory of the universe provides a prodigious amount of data which appears to support his predictions. For example, his theory predicts that the electronic transition of atomic hydrogen below its ground state of n=1 is a widespread phenomena which provides a significant amount of the energy radiated by all stars. The theory also predicts this transition reaction occurs in the atmosphere of some of the larger planets [Jupiter and Saturn] as well as in the dark regions of space. Hydrogen is the most abundant element in the universe, and if it also is able to exist in a stable form in lower energy states it must be measurable and detectable. There is substantial observational data confirming that possibility. One source is the extreme ultraviolet spectrometer data collected and analyzed by Simon Labov and Stuart Bowyer of the Center for Extreme Ultraviolet [EUV] Astrophysics at UC-Berkeley. They designed and had launched a diffuse, grazing





Peter Mark Jansson, P.P.,P.E. Page 26 of 73

incidence EUV spectrometer into space from White Sands Missile Range in the spring of 1986. They analyzed their data and published it in the Astrophysical Journal in the spring of 1991. Their data is remarkable in many ways; 1] it was not believed that such data could be collected, 2] they observed and validated significant emission features and signatures from the dark regions of space, 3] they acheived a very high statistical confidence that the data was real [in many cases >99% confidence] and 4] their explanations for what these emission signatures must be postulate that an unexplainably high temperature [million degree gases] must exist in what was otherwise believed to be a vastly cold region.

Upon review of this data the scientists of BLP, being chemists by background believed that "hot interstellar gas" view of dark space was not very plausible. They undertook to view this data in light of the fundamentals of the Mills' theory which predicts that lower energy hydrogen can collide with other lower energy hydrogen atoms and undergo an energy transition to a lower non-radiative energy state. These transitions radiate at specific energy levels and wavelengths as predicted by equations (1d) and (1e) as described above. While the Labov and Bowyer's interpretation of these signatures originating from hot interstellar gases $[Fe_{XIX}, FE_{XI}, O_V, \text{ etc.}]$ is more widely accepted by astrophysicists, other scientists see the explanation as less plausible.

The BLP assignment of these and many other planetary, stellar and interstellar radiation signatures to a calculated amount of energy being released from hydrogen atoms undergoing collisional effected transitions to lower energy states appears to be much more plausible. When the data is analyzed and one views the assignments of the probable hydrogen transitions and sees the reasonableness of such a theoretical match it appears to be much more than a remarkable coincidence. The analysis provided by BLP in Table 1 [on page xiii of the Forward] as well as page 424 of the text on the theory $^{[27]}$ shows a match between the background data and theoretical transitions for nearly all of the transitions that are probable to the n = 1/8 state of hydrogen. I have reproduced these calculations in Appendix 3 and provide a summary of one of those spreadsheets on the page that follows as Figure 2.2.

Perhaps an even more compelling way to view this data is in the manner developed by Jim Kendall, P.E., a Ph.D. Nuclear Engineer from Technology Insights [a technology assessment firm from southern California]. He graphically stacked the Labov and Bowyer data side by side with Mills theory predictions as shown in Figure 2.3 to reveal a correlation which is most persuasive.





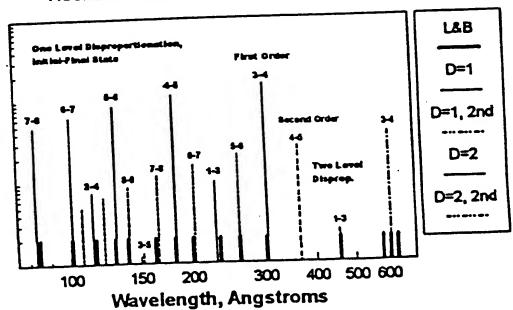
Peter Mark Jansson, P.P.,P.E. Page 27 of 73

FIGURE 2.2 - Astrophysical Observations and Mills Theory

Raw Extreme UV Background Spectral Data *

		Raw Extrem	<u>e UV Back</u>	ground S	Spectral Da	ata '	SIGTER
	OBSERVE		E	ractiona	<u> State</u>	MILLS PRE	
	Waveinth	Energy	Calc	1/nf	1/ni	WaveInth	Energy
5 10	A	eV	eV			A	eV
Peak	• •	146.2	146.2	8	7	82.9	149.6
1	84.8		122.2	7	6	101.3	122.4
2		122.2	106.2	Ā	2	114.0	108.8
3		106.2	95.7	6	5	130.2	95.2
4	129.6	95.6		4	2	141.6	87.6 He scattered
	139.6	88.8	88.8	1	7	165.8	74.8 2nd order Peak 1
(163.2	75.9	76.0	8	<u>'</u>	182.3	68.0
•	7 181.7	68.3	68.2	5	•	202.6	61.2 2nd order Peak 2
:	B 200.6	61.8	61.8	7	6	202.0	54.4
	9 233.8	53.0	53.0	3	7		46.8 He scattered
	0 261.2	47.5	47.5	5	4	265.0	40.8
1			√ ⊬41.0	·. 4.	.,, 3 .	303.9	27.2 2nd order Peak 9
	2 459.1	27.0	27.0	3	1	455.9	a . a the From December
	3 584.0		21.2			584.9	Took 44
	4 607.5		20.4	4	3	607.8	an a tile seelleend
_	· •		19.6	4	3	633.0	40.0
		, , , , , , , , , , , , , , , , , , , ,		3	2	911.7	13.6
٦	16						

FIGURE 2.3 - Astrophysical Data vs. Mills Theory Illustrated







Peter Mark Jansson, P.P.,P.E. Page 28 of 73

The analysis completed by this researcher in Appendix 3 corroborates the findings of BLP in regard to the extreme ultraviolet data in the background of space [above] as well as from our star, the Sun, as well as from a stellar flare on AU Mic and star EQ Pegasi. Dr. Mills' text also provides many other sources of astrophysical data which produce information that regularly display the lower energy hydrogen transition energies that would be most likely from a probabilistic standpoint. Table 2.4 on the page that follows lists the most commonly occurring wavelengths and energies in all of the data described above [ie; data that appeared in at least 3 of the 4 sources cited] and the match I have calculated for that data by equation (1e) above.

TABLE 2.3 - Commonly Observed Wavelengths & Mills Theory Predictions

Wavelength A	Mills Theo Å	Mills Theory Wavelength & Hydrogen Transition A Initial Stage → Final Stage				
•		-				
911.8	912.3	1/2 -> 1/3	1*			
302.8-304	303.9	1/3> 1/4	3			
261.2-265	265.0	1/4> 1/5 He scattered	3			
182-183	182.3	1/4 -> 1/5	4			
	130.2	1/5 -> 1/6	4			
129.1-130	122.6	1/6 -> 1/7 He scattered	3			
122.2-123	,		4			
101-101.3	101.3	1/6 → 1/7	3			
89-90	89.0	1/7 -> 1/8 H scattered				
81-81.1	81.1	1/3> 1/5 H scattered	3			

NOTE: Only one source, the solar spectral data, included observations above the 600 Å wavelength

2.3 Enigmas Solved

Perhaps the two most compelling enigmas that the Mills theory resolves are solar problems. They are; an inadequate solar neutrino flux and a solar coronal temperature that is inexplicably too hot. For two decades we have known that the standard solar model predicts that the primary energy source of our star is the nuclear fusion of hydrogen atoms. The problem is that scientists have been unable to account for an appreciable amount of the solar neutrino flux that would be predicted by assuming all of the Sun's radiant energy is from fusion. The Gallex solar neutrino detector in Italy sees only 60% of the neutrinos that the standard solar model would predict. ^[29] The Homestake detector reports neutrino flux of 2.1 ± 0.03 SNU or only 27% of the standard solar model's 7.9 ± 2.6 SNU. Where





Peter Mark Jansson, P.P.,P.E. Page 29 of 73

then, if not fusion, could the rest of the Sun's energy be coming from? A similar problem exists with the description of all of the Sun's energy coming from nuclear fusion when we consider the temperature gradient from the surface of the Sun into space. The photosphere [visible surface layers] of the Sun is 6000 K, "whereas the temperature of the corona [solar atmosphere] based upon the assignment of the emitted X-rays to highly ionized heavy metals is in excess of 1,000,000 K." The Mills theory is able to explain both of these seeming mysteries by postulating the disproportionation of hydrogen atoms in the atmosphere of the Sun. This transition of hydrogen to lower energy states as previously discussed gives rise to significant non-nuclear radiant energy [ie; transitions of hydrogen to the n = 1/100 level yield energy densities (139 keV) on the order of nuclear reactions]. The disproportionation reaction takes place in the coronal region of the Sun giving rise to the much higher temperatures there. Together the Mills theory makes sense of what otherwise could only be explained by difficult-to-believe concepts. The standard solar model has no answers for this enigma but two theories attribute the higher coronal temperature to "the conversion to heat energy by the dissipation of the energy in electric currents or magnetohydrodynamic [MHD] waves." If the corona consists of an "almost fully ionized plasma contained in closed magnetic field loops or of plasma expanding outwards along open magnetic field lines" it is quite a stretch and additional complication to propose the electric currents or MHD.

Another key enigma solved is that of the total mass or matter in the universe. For years physicists have been wrestling with the fact that either "black holes" or an unidentified "dark matter" must exist out there in space in order to explain why our calculated mass of the universe can not be obtained by adding up all of the radiative and observable matter. We need more mass to explain the observation that galaxies rotate at a higher angular velocity than possible with only the observed [visible] matter providing the stabilizing gravitational attraction. Is it too much a stretch for the logical mind to postulate that if over 95% of the known matter of the universe consists of hydrogen that the large amount of "missing matter" may also be some non-radiative form of hydrogen? Mills theory predicts that stars consume hydrogen and convert it into lower energy state hydrogen as the "ash" residue of the reaction. This ash is non-radiative, microscopically smaller than ground state hydrogen and is believed by Mills to be ubiquitous throughout the universe. It would appear to be an excellent candidate for the undiscovered, yet ubiquitous dark matter of the universe.

2.4 Technological Embodiments

This final section of Chapter 2 is devoted to devices and apparatus that have been designed and operated by BLP scientists in order to prove that the catalytic reduction of atomic hydrogen below its ground state of n=1 is not only acheivable but is repeatable,





Peter Mark Jansson, P.P.,P.E. Page 30 of 73

predictable and consistent. Table 2.4 below indicates the types of devices that have been designed and developed by BLP scientists to demonstrate the phenomenon.

TABLE 2.4 - BLP Technologies

Device	Туре	Other
Dewar Flask Electrolytic Cell Electrolytic Cell Non-Electrolytic Cell Glass Lamp	Electrolytic Cell Electrolytic Cell Electrolytic Cell Gas Phase Gas Phase	DC electricity AC electricity
Isothermal Calorimeter Calvet Calorimeter Nickle Hydride Wire Cell Quartz Firebrick Cell Test Cell 1	Gas Phase Gas Phase Gas Phase Gas Phase Gas Phase Gas Phase	Oven Moderated Water Cooled Steady State Flow

Furthermore, all of the devices in the above table exhibit the ability to generate anomolous heat that is inexplicable by any known chemical or nuclear reactions. These devices generate heat with no flux or radioactive materials, reduction or consumption of known chemical or molecular reactions or bonds and follow directly from the Mills theory. The specific devices are in essence the embodiment of his concepts for bringing hydrogen atoms into contact with a catalyst in order to begin the hydrocatalysis and subsequent disproportionation reactions. The devices developed by BLP are both test and demonstration units.

The two and one-half pages following below provide illustrations of some of the key BLP technological embodiments. Figure 2.4 illustrates the dewar experimental vessel. Figure 2.5 shows the typical arrangement for one of BLP's advanced electrolytic cells. Figure 2.6 illustrates the device developed by the BLP joint venture with Thermacore — a non-electrolytic first generation gas phase cell. Figure 2.7 illustrates the isothermal calorimeter and Figure 2.8 is a typical Calvet calorimeter arrangement. I am focusing on these few devices to keep the reader directed to the specific technological embodiments of the Mills theory that demonstrate that the production of excess and anomalous heat from each apparatus is conditional upon bringing all of the elements of Mills' theoretical requirements to the experiment. If any one of the key elements is





Peter Mark Jansson, P.P.,P.E. Page 31 of 73

missing, the experiment functions as a typical control with no excess heat being produced.

FIGURE 2.4 - Dewar Experimental Cell

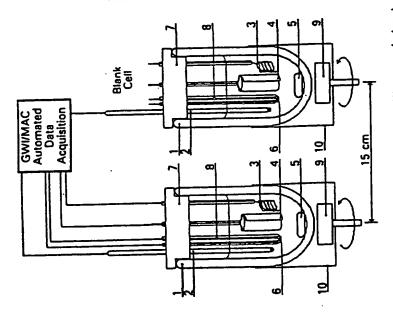


Fig. 5. Experimental calorimeter setup: (1) vacuum-jacketed dewar, (2) thermistor, (3) platinum anode, (4) nickel cathode, (5) magnetic stirring bar, (6) resistor-heater, (7) Styrofoam stopper lined with Parafilm, (8) Teflon tubing, (9) magnetic stirrer, and (10) aluminum cylinder.

FIGURE 2.5 - Advanced Electrolytic Cell

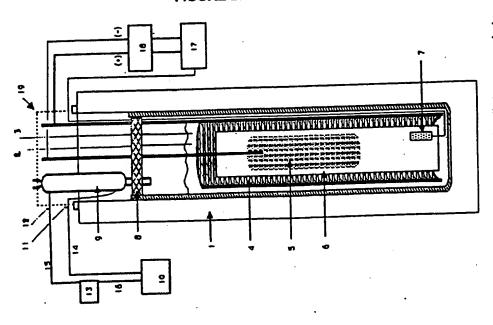


Fig. 1. The calorimeter/electrolysis cell: 1 = vacuum jackered dewar, 2 = electrolyte thermistor, 3 = conductivity sensor, 4 = nickel anode, 5 = nickel cathode, 6 = Teflon spacer, 7 = resistor heater, 8 = Teflon cap, 9 = condenser, 10 = peristalite pump, 11 = intermistor, 12 = outlet thermistor, 13 = water

reservoir, 14 = condenser inlet tubing, 15 = con-

denser outlet tubing, 16 m reservoir to pump tubing.

17 = power supply, function generator, power meter, 18 = oscilloscope, 19 = insulated cap.





Peter Mark Jansson, P.P.,P.E. Page 32 of 73

FIGURE 2.6 - Non-Electrolytic Gas Phase Cell

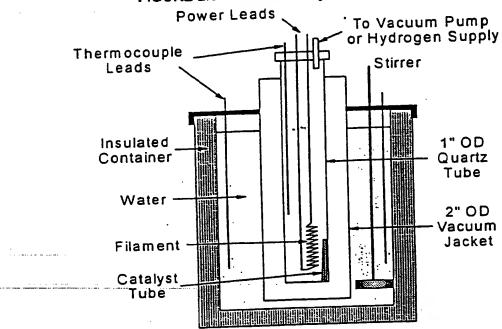


FIGURE 2.7 - Isothermal Calorimeter Gas Phase Cell

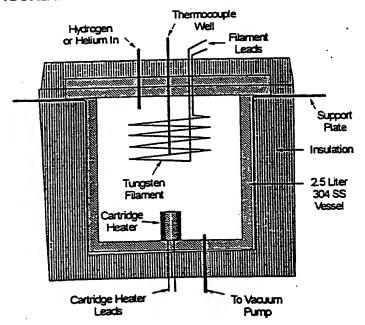


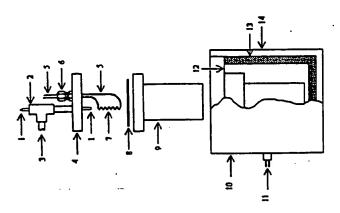






FIGURE 2.8 - Calvet Calorimeter Gas Phase Cell

Figure 1. Schematic of the Gas Cell for the Calvet Calorimeter and Cross Sectional View of the Calvet Calorimeter. 1 - (1/16)* OD stainless steel tube (to hydrogen supply), 2 stainless steel tee union, 3 - (1/4)* OD stainless steel tube (to vacuum manifold), 4 - cell lid, 5 - filament leads, 6 - Conax-Buffato gland, 7 - precision resistor, 0.1 mm OD tungsten filament, or nicket hydride filament treated with catalyst, 8 - copper ring gasket, 9 - cell body, 10 - Calvet Calorimeter, 11 - thermopile signal output, 12 - thermal shunt, 13 - thermopile, 14 - insulated calorimeter base.



In the case of the electrolytic cells it is very important that the hydrogen atoms be formed on the cathode contact with the right concentration of the catalytic ions in order for the heat generation phenomenon to be replicated. In the case of the gas cells a small, partial atmosphere of hydrogen gas, a small partial pressure of the catalytic ions as well as a mechanism to cause hydrogen dissociation all need to be present for the reaction to commence and continue. The experiments and subsequent demonstration units were designed specifically to assure that the mean free path for the hydrogen atoms [once formed] to interact with and collide with the catalytic ions was appropriate to favor the collision and catalytic reaction prior to hydrogen atom recombination into H₂.

Each of the cells illustrated above were able to regularly, consistently and repeatedly generate heat in amounts that were far in excess of the any known chemical reaction for hydrogen and any other known elements. In the case of the vacuum gas cells this reaction was developed and maintained using only very small amounts of hydrogen gas, a filament to dissociate H₂ into its atomic form and a catalyst with the appropriate resonant enthalpy of 27 eV. Part II of this thesis will highlight the performance of BLP's isothermal cell, Penn State University's Calvet cell experiments as well as the experiments of this researcher in the Calvet cell at BLP laboratories.

To more fully document the BLP theory that lower energy hydrogen [hydrino formation] was the source of the heat in the reaction, the residue "ash" as it were from the reaction gases from both the electrolysis and vacuum cells was collected. According to Mills theory this "ash" should contain the lower energy form of hydrogen postulated by





Peter Mark Jansson, P.P.,P.E. Page 34 of 73

BLP. The difficulties of capture make this effort quite a challenge since the atoms being searched for will have significantly smaller diameters than the smallest of all atoms. BLP and four other scientific laboratories began this search a few years ago. They used the methods of mass spectroscopy, gas chromatography and X-ray photoelectron spectroscopy [XPS]. Table 2.5 below highlights the results of those investigations thus far.

TABLE 2.5 - The Search for Hydrinos

Device	Results/Observations	Investigating Laboratory
Mass Spectroscopy	Large signal with ionization energy in calculated range of dihydrino	BLP Laboratory Air Products & Chemicals Lab Schrader Analyt. & Cons. Lab
Gas Chromatography	Significant signal peaks which can be associated with n=1/2, 1/3 and 1/4 dihydrino molecules	BLP Laboratory
X-Ray Photoelectron Spectroscopy [XPS]	Signal Peaks associated with the binding energy of n=1/2, 1/3 and 1/4 hydrino molecules	Lehigh University - Zettlemoyer Center for Surface Studies Idaho National Engineering Lab Clark Evans & Associates

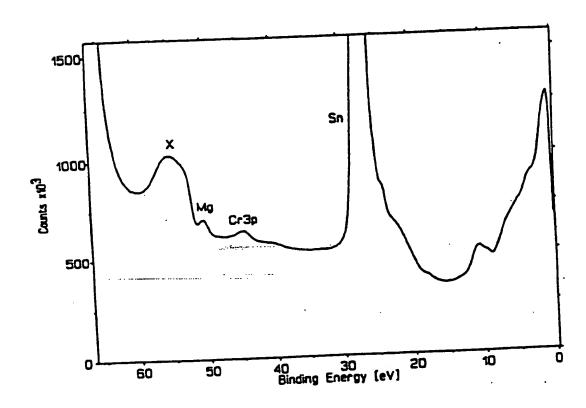
Figure 2.9 which follows on the final page of Part I illustrates the location of an anomalous peak near 55 eV binding energy which was detected by Zettlemoyer Center for Surface Studies at Lehigh University, Charles Evans & Associates and Idaho National Engineering Laboratories [INEL] in separate analyses of BLP and INEL samples. BLP asserts that the n=1/2 state of hydrogen, which has a calculated binding energy of 54.4 eV, is the source for the peaks in each independent study. At present all other potential known sources of a peak at that energy level [i.e. Fe_{3p}] have been ruled out as a source.





Peter Mark Jansson, P.P.,P.E. Page 35 of 73

FIGURE 2.9 - XPS Anomalous 55 eV Peaks







Peter Mark Jansson, P.P., P.E. Page 36 of 73

PART II - Analysis of Previous Experimental Results

As noted in Chapter 2 [Table 2.1] there have been a substantial number of tests of BLP electrolytic cells. This researcher was not able to find any documented results from tests that had been performed on BLP cells which indicated that the cells did not operate in a manner to generate the anomalous heat predicted by BLP scientists. However, due to the controversial nature of electrolytic cell and the close association of the work with the continuing debate regarding cold fusion claims I have directed my research toward reviewing the test results which have been achieved in the gas phase cells. It is worthy of note at this point that there continue to be significant publications in Fusion Technology where well respected scientists are continuing to claim excess heat in so called "cold fusion" cell experiments. Of particular note is a recent technical paper in the March 1997 Fusion Technology journal. The authors [from Shell Research / CNAM Laboratoire des Sciences Nucléaires in Paris, France] describe how they have detected and verified that they are creating excess energy from hydrogen "7300 times higher than the most exothermic known reaction" at a high confidence level [99%]. They also detect missing hydrogen in their exhaust samples. Further, they present their postulate that the source of the additional energy is from "the formation of a tightly bound state of hydrogen...In such bound states, the electron is much closer to the proton than in normal hydrogen. This could explain both a high energy of formation and a greater than normal capacity to diffuse through any material" [37] All of these findings are consistent with the Mills theory. Part II of this thesis will focus on summarizing the results of two of the gas phase cell experimental results developed to date noting with special interest the experiments conducted by this researcher in section 3.3. In each case the gas phase cells produce a statistically significant [ie; beyond the error range and accuracy of the measuring device] amount of unexplainable heat. In the experiments the heat generated is well beyond the most energetic of chemical reactions known for hydrogen. I will attempt to explain, when possible potential reasonable alternative explanations for the repeatedly observed phenomenon. Often, however, there is no reasonable explanation other than the potential for a new energy source resulting from the interaction of hydrogen and the catalyst materials in the cells. After summarizing all of the gas phase cell experiments, the results of a singular isothermal cell test will be reviewed in detail [the experimental results from this cell formed the basis for the computer modeling work detailed in Chapter 4]. Results from the Penn State University cell will be reviewed and then the closing section will summarize the results of my work with Mr. William Good, the Chief Scientist and Director of Research & Development at BLP.

Chapter 3 - Summary Review of Gas Phase Cell Experimental Results

Table 2.4 illustrated seven gas phase cell experimental devices. I will provide a detailed explanation the operation of two of these devices in sections 3.1 through 3.3. I will place special focus [sections 3.2 and 3.3] on the Calvet device [see Figure 2.8] which is the most accurate in measuring the heat generated in a BLP reaction. Prior to the announcement of the hydrocatalysis process developed by BlackLight Power the







Peter Mark Jansson, P.P., P.E. Page 37 of 73

paradigm for hydrogen as a fuel revolved around its energetic reaction with oxygen. In nature, water [H2O] is a very abundant, stable and versatile molecule. Hydrogen is very energetically bound to oxygen, and requires significant energy to break these these stable bonds to yield H₂. After they are broken, hydrogen in its molecular form [H₂] is also stable, but reacts well and energetically with many other elements to form a plethora of molecules and compounds. The basic principle being tested with the gas phase cells of BLP is the ability of the hydrogen atom, once dissociated from its molecular form, to undergo electronic transition to lower energy levels [as described in Chapter 2] when it collides with a catalyst. All of the experiments therefore that will be described in the next three sections are configured to provide a reaction chamber [capable of operating at vacuum or near vacuum pressures], a means for hydrogen to be introduced to the chamber, a catalytic material to be introduced in the reaction chamber, a means for dissociating the hydrogen molecule into its atomic form, and a method for measuring heat generated by the reaction. Fundamentally the two cells reviewed in Chapter 3 are identical in nearly all respects except for the method for measuring or determining meaningful heat generation. The Calvet cell utilizes very accurate thermopiles to measure the heat flowing out of the vessel into the constant temperature oven. The isothermal cell uses the laboratory environment as the 'stable' external temperature and assumes the internal cell temperature represents a steady state heat loss previously measured by control runs to yield an 'estimate' of the additional power [anomalous heat] being provided by the reaction in a more indirect way. The Calvet cell experiments yield heat on the order of 6% to 12% more than energy being provided by the reaction than that used in the reaction zone [0.6 to 1.2 watts over a 10 watt filament power]. The isothermal cell experiments indicate heat gains of 52% to 171% over the energy being provided to the reaction zone [43 to 55 watts over a 32-86 watt input power]. It is the isothermal cell experiments that are of the greatest interest to this researcher since they portend the greatest potential for creating commercially significant heat. Section 3.1 focuses specifically on that BLP technological embodiment.

3.1 BlackLight Power Isothermal Cell

In the laboratory of BLP in Malvern, Pa. this researcher observed an experimental test on May 1, 1996 which was quite intriguing. A stainless steel vessel of 2 liters in volume was evacuated to a pressure of 1150 millitorr. [760 torr = 1 atm.]. This vessel was being maintained at a steady state temperature of 275° C by way of a cartridge heater consuming 97.1 watts located in the base of the vessel [see Figure 2.8]. The only materials inside this vessel were a 200 cm tungsten filament [0.01 cm. diameter] supported by 4 ceramic rods connected by 1/8th inch stainless steel tees and 3 grams of KNO₂ catalyst. Hydrogen was introduced into the system at a pressure of 1 atmosphere, the valve to the vacuum was opened and the pressure reduced to 2 torr minutes later. When the vacuum vessel comprised a closed system it had a steady state pressure of 1150 mtorr. When the power to the tungsten filament was turned on and raised to 15 watts the cartridge heater turned off and did not come back on for about one half hour. The temperature rose from







Peter Mark Jansson, P.P., P.E. Page 38 of 73

275° C to about 285° C during this period. When the cartridge heater did begin cycling again to maintain the vessel temperature at approximately 275° C it did so at a steady state energy consumption rate of 48.5 watts. [The details of this experiment are found in Appendix 4] The filament wattage was successively increased to 25 watts, 35 watts and 40 watts in three additional steps during which the cartridge heater energy decreased to 17.2 watts, 5.7 watts and 0 watts respectively. The vessel continued to maintain a temperature of 288-289° C without any energy being provided by the cartridge heater. The filament steady state power consumption was 40 watts indicating that something [presumably the Hydrocatalytic effect] occurring within the vessel appeared to be providing the additional 57 watts of heating that was necessary to keep the vessel at temperature. If one assumes that all the data being gathered on this closed system [i.e; energy in, temperature, pressure and chemicals involved] are accurate, then this appears to be a compelling illustration of this technology's capability. Table 3.1 illustrates a significant number of BLP experimental and control runs on their isothermal calorimeters.

I have summarized the results for each of the runs but the reader is encouraged to review the detailed data in Appendix 5. The Appendix includes all of the detailed experimental data as well as the analysis completed by this researcher. It is clear from the few control studies that the isothermal cell exhibits different behavior when it is operating on filament power versus cartridge heater power. As shown in experiments 15.5 and 15.8 the isothermal cell uses significantly less power with the filament than that required on the cartridge heater. This researcher believes that this apparent 25-54% savings may be due to four factors in the following order of significance; 1] The relative distances between the heating sources and the thermocouple [The filament was closer in proximity to the thermocouple and therefore had greater radiant coupling], 2] Radiant coupling of the filament with the thermocouple may have resulted in the thermocouple being at a higher temperature than actual temperature. [This condition would allow the cell to cool down and thus reduce to some degree its heat loss and associated energy requirements]. 3] Increased stratification may have occurred under filament power [i.e.; convective mixing of gases may not have occurred sufficiently allowing stratification. With the upper regions of the cell warmer than the lower regions of the cell heat loss would have decreased across the entire cell surface]. 4] In the case when the cartridge heater was the only source of power, heat loss through the bottom of the cell may have been higher, thus the thermocouple in the cell will need to see greater power from the cartridge heater in order to cycle off the power. It is important to note that another way of considering this last point is that the filament provided all of its heat interior to the cell most efficiently, while the cartridge heater entered through and was connected to the bottom surface of the calorimeter allowing a larger percentage of its heat energy to leave the cell without affecting thermocouple temperature.

Nonetheless, it is important to note that experiments 15.4, 15.6, 15.9 and 15.10 all create anomalous heat far beyond the cartridge/filament differential calculated by the control experiments. From the heat loss model developed on these cells in Part III of this







Peter Mark Jansson, P.P.,P.E. Page 39 of 73

thesis it appears that the isothermal cells are able to create at least tens of watts of useful power even in their very primitive development state.

TABLE 3.1 - Isothermal Cell Results Summary

Experiment #	Temp	Pressure (Torr)	Watts [Heater]	Watts [Filament]	Excess Heat [Watts]	Power Gain [%]
15.4	259	2.0	95.2	45.7	49.5	108.3%
15.5 control	273 273	low atm 2.0	94.3 94.3	61.3 75.7	33.0 18.6	53.8% 24.5%
15.6	271	1.4	92.0	43.6	48.4	111.0%
15.8 control	261	low atm	87.3	62.5	 24.8	39.7%
15.9	280	1.7	103.5	41.7	61.8	48.2%
15.10	264	1.6	92.7	32.2	60.5	187.9%
15.12	284	0.02	106.0	97.8	8.2	8.3%
15.13	319	1.9	131.2	83.6	47.6	56.9%

It is recommended that the isothermal cells be outfitted with external temperature measurement thermistors and that a full set of controls and experiments be carried out on these cells. From this work we can develop heat loss calibration curves under various temperature and pressure regimes. In addition, each cell should be blanketed with a standard jacket to reduce heat loss variability from experiment to experiment. From a very high temperature the cell should be turned off and a heat loss decay model be fit to its heat loss rate over time. This empirical model could then be used as a second source of validation for the calculated excess energy created in the hydrocatalytic reaction within the vessel.

3.2 Penn State University Calvet

In late 1996 Dr. Jonathan Phillips, Professor of Chemical Engineering at the Pennsylvania State University, and Julian Smith, his graduate research assistant undertook significant control experiments and tests on the heat generation of gas phase Hydrocatalysis. A complete copy of their report and findings is provided in Appendix 6. The Calvet cell





Peter Mark Jansson, P.P., P.E. Page 40 of 73

that they used is shown in Figure 2.9. The Calvet calorimeter cell is configured much like the isothermal cell described above but it includes much more accurate direct measurement of heat flux out of the reaction vessel. This measurement device is accurate to within 0.5% in recording energy flow. Unfortunately, in order to gain this extremely high accuracy one must place this vessel into a very controlled environment and into a thermopile base. This makes a large device very costly. The size of the Calvet cells used by Penn State are 20 cubic centimeters. The tests were conducted during the period of October - December 1996 in Penn State Chemical Engineering Department laboratories. The following excerpt from the report summarizes their key work and findings; "In three separate trials between 10 and 20 K Joules were generated at a rate of 0.5 Watts, upon the admission of approximately 10⁻³ moles of hydrogen to the 20 cm³ Calvet cell containing a heated platinum filament and KNO₃ powder. This is equivalent to the generation of 1x10⁷ J/mole of hydrogen as compared to 2.5x10⁵ J/mole of hydrogen anticipated from standard hydrogen combustion. Thus, the total heats generated appear to be two orders of magnitude too large to be explained by conventional chemistry, but the results are completely consistent with the Mills' model." [38]

It is noteworthy that in all cases the Penn State tests [summarized in Table 3.2] were terminated by removing the hydrogen from the reaction vessel by opening the valve to the vacuum and pumping the gas from the vessel. It is not clear how long these reactions would have continued if the vessel was not emptied of the hydrogen gas. The method used by PSU included bringing their Calvet reactor cell to steady state in a controlled environment oven with only a platinum filament and small vessel of KNO₃ present within the reactor vessel. They would zero out the Calvet output at this point and then admit hydrogen to observe the reaction that this precipitated. There experiments showed a significant exothermic reaction upon the admission of hydrogen which could not be replicated upon the admission of helium [which they used as a control gas for their experiments]. In all cases this exothermic reaction was curtailed by the researchers once the total energy that had been produced was significantly greater than that available in known chemical reactions of hydrogen.

TABLE 3.2 - Penn State Calvet Cell Results Summary

Experiment #	Temperature (°C)	Pressure (Torr)	Total Time (minutes)	Total Energy (Joules)	Excess Heat (milliWatts)
BL1218CD	250	170	612	21,560	586.8
BL1220BC	250	180	364	13,003	595.9
BL1221AB	250	120	284	10,293	604.7
					•





Peter Mark Jansson, P.P.,P.E. Page 41 of 73

3.3 Jansson Calvet

In early 1997, this researcher approached Mr. William R. Good, Research Director of BLP to discuss the possibility of replicating the isothermal cell work at BLP to determine more conclusively the primary parameters of the gas phase reaction. It was this researchers intent to determine the effect of filament surface area on excess heat formation as well as begin parameterizations of other key variables such as reaction zone volumes, gas partial pressures, temperature, and other variables. BLP was most gracious in offering their Calvet cells for any experiments I would choose to run. The isothermal cells could be used as a follow-up in the event that the data from the Calvet work indicated a significant isothermal cell demonstration was feasible. In as much as it is believed that the formation of excess energy is caused by hydrogen atoms colliding with catalyst ions or hydrinos, I undertook to prove that increasing filament surface area would increase atom generation rate and thus increase power output from the Calvet cell. The protocol for my experiments is included as Appendix 7. A copy of my control and experimental results are included as Appendix 8. My original intent was to reproduce the Penn State experimental results and then go on to vary only the filament length in two subsequent experiments. If this could be done successfully, I believe it would demonstrate that specific parameters of the reaction could be controlled and engineered. We followed the PSU protocol in all aspects except reaction vessel pressure; this was because it appeared we were unable to demonstrate the excess heat effect at the 150-1000 torr range where the PSU reaction had operated successfully. We were successfully able to replicate numerous times the anomalous heat gain results in the 50-200 mtorr pressure regime. When we completed many of our post-experimental calibrations without the KNO3 catalyst we believe we were able to identify excess heat that was being generated from the small amount of hydrogen that was off gasing from the platinum filament. This is my present interpretation of the results I obtained. Presently I can not offer an alternative expalantion for the consistent excess heat activity when only the filaments and KNO₃ catalyst are present in the experiments. Table 4.3 below summarizes my testing objectives.

TABLE 3.3 - Jansson Calvet Testing Objectives

- Replication of PSU Results
- Vary Filament Length [10cm , 20 cm , 30 cm]
- Analyze Results for Consistency and Patterns
- * Determine if Effect Appears Engineerable
- * Develop New Technical Skills and Knowledge





Peter Mark Jansson, P.P.,P.E. Page 42 of 73

Table 3.4 below summarizes the 9 experiments and controls that I performed during the period of February 27 through May 5 1997. Each was conducted according to the primary protocol summarized in Appendix 7.

TABLE 3.4 - Jansson Calvet Tests Completed

- * 20 cm Experiments 1 control 2 experiments February 27 - March 21, 1997
- * 10 cm Experiments
 1 experiment / post control-calibration run
 March 25 April 13, 1997
- * 30 cm Experiments
 1 control
 4 experiments
 March 22 25, 1997
 April 13 May 5, 1997

The following tables [3.5 & 3.6] summarize the testing protocol which was followed for each of the controls and experiments conducted in the BLP laboratories:

TABLE 3.5 - Jansson Calvet Testing Protocol Summary - Control

- Prepare Calvet Reactor Vessel
- ♦Install Filament and Vacuum Test
- Place Calvet in Thermopile Cup
- ◆Vacuum test, connect leads, insulate
- Bring Oven & Calvet to Steady State
- +250° C, vacuum cell to remove all H₂O, etc.
- Start DAS, Turn On Power, Close Vac.
- +0,1,5,6,10,11,15,16, etc. watts to steady state
- Wait Until Steady State is Acheived
- Observe Changes in V_C





TABLE 3.6 - Jansson Calvet Testing Protocol Summary - Experiments

- Prepare Calvet Reactor Vessel
- ◆Install Filament, KNO3, Vacuum Test
- Place Calvet in Thermopile Cup
- ◆Vacuum test, connect leads, insulate
- Bring Oven & Calvet to Steady State
- +250° C, vacuum cell to remove all H₂O, etc.
- Start DAS, Turn On Power, Close Vac.
- ♦0,1,5,6,10,11,15,16, etc. watts to steady state
- Wait Until Steady State is Acheived
- +Stable V_C, W_{in}, V_f, KNO₃ vapor pressure
- Observe Changes in V_C
- Inlet H₂ to Double Current Pressure*
- Wait 5 min. and Vacuum Down to < 0.1 T
- Observe Changes in V_C

NOTE: V_c is the Calvet calorimeter voltage indicative of heat output, W_{in} is the total energy being consumed by the filament within the Calvet, V_t is the Voltage associated with the energy being dissipated by the filament [allows us to know I2R losses], and vapor pressure is measured in mTorr.

 ullet in all cases it was not necessary to add additional H_2 in order to observe an elevated V_c

Table 3.7 below illustrates the calibration curves and linear regression analysis fits which I obtained for each of the control runs used in calculating the excess heat from each experiment.

TABLE 3.7 - Jansson Calvet Testing - Calibration Curves

$$= 20 \text{ cm}$$

 $+ \text{V}_c = 0.2333 \text{ (Win)} - 0.0605$ $R^2 = 0.9996$

■ 30 cm
•
$$V_c = 0.2297 \text{ (W}_{in}) + 0.5188$$
 $R^2 = 1.0000$





Peter Mark Jansson, P.P., P.E. Page 44 of 73

Pages 45-51 graphically and tabularly depict the results of the many days [over 555 hours] of analyzed Calvet cell experiments and controls. The results begin with a summary slide and then summarize the data by 10 cm., 20 cm. and 30 cm. experimental and control runs. These are labeled Figures 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 and 3.7. Table 3.8 below is a numerical summary of the results obtained for all KNO₃ experiments as well as KNO₃ plus hydrogen experiments. All excess heat calculations for the experiments is based upon the difference between the Calvet output power anticipated via the control runs contrasted with the actual input power used to generate that Calvet voltage output during the experimentals. All controls and experimentals were completed in a closed system in an oven with temperature of 250 °C. In all cases the vacuum integrity of the reaction vessel was maintained throughout the entire run of the experiments.

Table 3.8 Jansson Calvet Cell Results Summary

Filament Length [cm]	Excess Po Mean	wer Genera Max	ted [Watts] Min	Hours of Operation	Total Energy Produced [W-hrs]	% Over * Chemical
10	0.581	0.635	0.523	297.97	173.013	234,387
20	0.818	1.231	0.337	125.22	102.464	138,090
30	1.572	2.092	0.635	131.95	207.467	278,151

^{*-%} Over Chemical - is the amount of energy generated by the reaction divided by the energy that would have been created had all of the hydrogen available at anytime in the experimental apparatus been consumed in the most energetic chemical reaction calculated [ie; hydrogen combining with oxygen to form water - H₂O] expressed in percent.

The energy produced by these experiments significantly exceeds that which could be released by any known or potential chemical reaction by several orders of magnitude. The value shown in the table above is extremely conservative in that it was determined assuming the following; 1] all potential hydrogen in the system was converted with perfect efficiency into water, 2] all of the impurities in the platinum wire [99.99% pure] were hydrogen, 3] all hydrogen admitted at any time into the reraction chamber reacted within the vessel, even though it was rapidly brought under vacuum pressure and drawn out early in each experiment. Even when these conservative assumptions are applied, there remains a significant and large amount of energy that is unaccounted for. This ranges from about 1,400 to 2,800 times the amount of energy that was available at any time to the system assuming it was able to be perfectly released in a chemical reaction. These results would appear to be entirely consistent with Mills theory.





Peter Mark Jansson, P.P.,P.E. Page 45 of 73

Figure 3.1

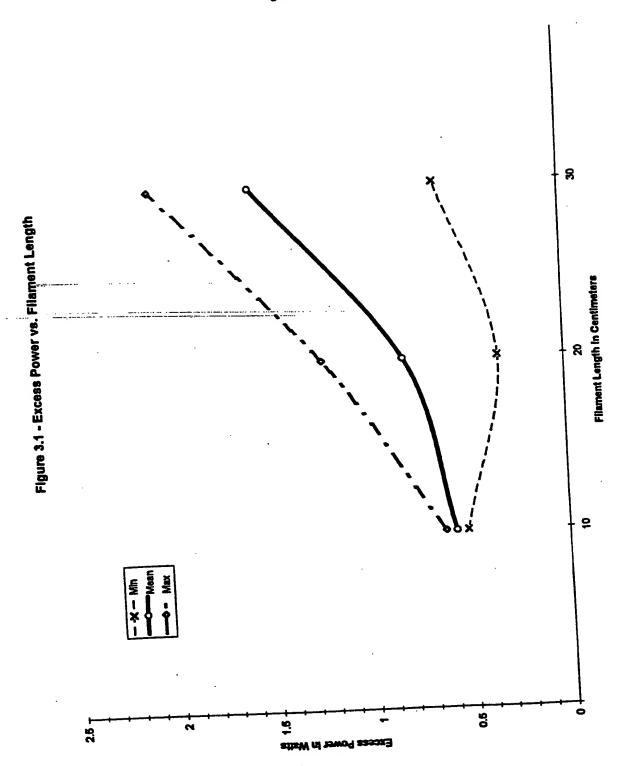




Figure 3.2

4.212 24.349 10.572 14.883 13.356 11.485 14.347 Energy Produced 14.940 173.013 14.786 Additional H22 Watt-hrs Yes Yes Yes Yes Yes Yes Minimum Std. Deviation % 0.14T 0.14T 0.13T 0.12T Power [Wetts] Std. Devlation 0.12T 0.14T Pressure 0.14T 0.14T 0.14-104T 0.13T Figure 3.2 - Summary of 10 cm Experimental Results 0.625 0.581 0.523 0.635 0.523 0.539 0.597 0.635 0.588 0.628 0.538 0.609 0.538 **Excess Power Iwatts** 23.438 25.018 21.428 45.618 23.558 23.558 23.904 17.872 297.970 8.053 45.175 17.708 Date[s] of Run Hours [88] fours of Operation 27-Mar 28-Mar 30-Mar 31-Mar 1-Apr 2-Apr 3-Apr 6-Apr 7-Apr 8-Apr 9-Apr

Figure 3.2 - Summary of 10cm



:::



Peter Mark Jansson, P.P.,P.E. Page 47 of 73

Figure 3.3

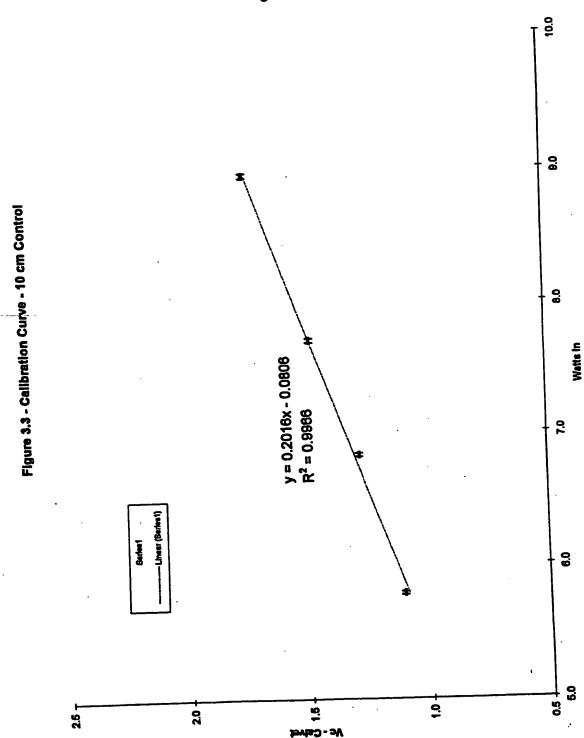




Figure 3.4

3,435 1,647 8,276 4,419 16,807 12,992 1,920 2,775 6,555 102.464 **Energy Produced** 1.879 Pressure Additional H22 | Watt-hrs Yes Yes No Xes Yes Yes Yes Yes Minimum Maximum Std Devietion **Std Devisition %** 253-265T 0.1-576T 253 0.075T 0.088T 0.088T 0.0675-0.069T 0.0675T Ave. Power (Wette) 253.7 0.15T-1.7etm 0.068-0.075T 50T-10pslg Figure 3.4 - Summary of 20 cm Experimental Results 0.337 0.568 0.568 1.164 1.231 0.879 0.446 0.818 0.337 1.231 0.286 0.577 Excess Power [watts] 31.194 14.781 3.576 6.870 5.575 4.272 2.889 13.635 7.464 14.439 125.223 5.820 tours of Operation Hours [88] 18-Mar 19-Mar 20-Mar 20-Mar 15-Mar 16-Mar 17-Mar 17-Mar Date[s] of Run

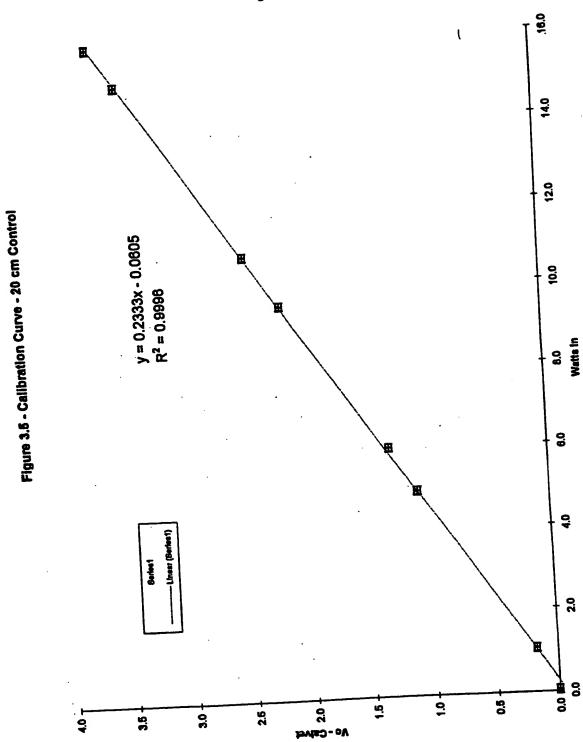
Figure 3.4 - Summary of 20 cm.





Peter Mark Jansson, P.P.,P.E. Page 49 of 73

Figure 3.5





Peter Mark Jansson, P.P., P.E. Page 50 of 73

Figure 3.6

fours of Operation 27.919 207.467 12.888 20.369 22.812 49.080 7.884 5.154 4.392 8.651 Additional H22 Watt-hrs **88 29 29 29** Yes Yes Std. Devlation % Minimum Maximum Std. Devistion Ave. Power [Wetts] 0.447-0.596T 0.385-0.683T 0.349-0.576T 0.425-0.582T 0.352-0.582T < 1.3127 0.335-0.4437 0.453-0.679T Pressure 0.386-0.591T 132.5-178.2T 0,36-549T 1,572 0,835 2,092 0,461 29,32% Figure 3.6 - Summery of 30 cm Experimental Results 1.669 1.335 0.635 1.954 2.067 1.264 1.135 1.079 1.181 Excess Power [watts] 11.572 23.461 13.507 6.237 11.355 15.160 12.060 21.273 6.916 131.950 5.632 tours of Operation Hours [ss] 14-Apr 16-Apr 17-Apr 18-Apr 23-Apr 25-Apr 3-May 4-May Date[s] of Run

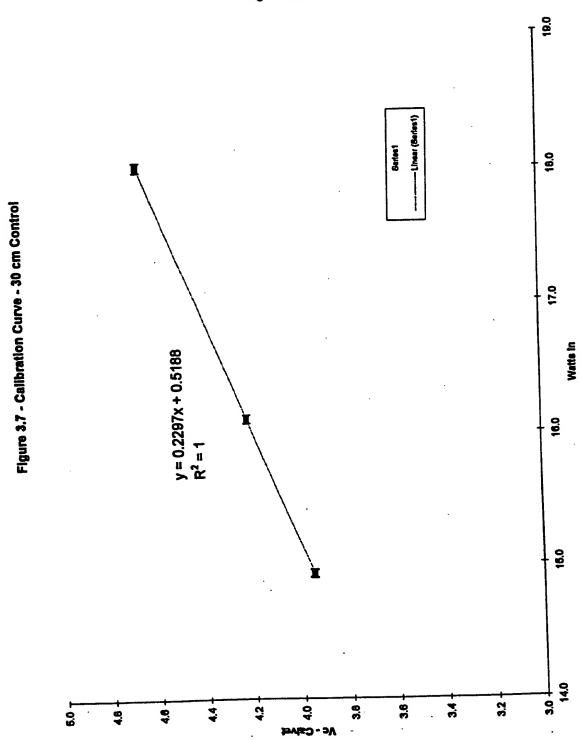
Figure 3.6 - Summary of 30cm.





Peter Mark Jansson, P.P.,P.E. Page 51 of 73

Figure 3.7









PART III - Mathematical Simulation Model

In order to assess the commercial potential of the BlackLight Power technology I performed some mathematical simulation modeling on one of their most promising devices. The isothermal cell described in Section 3.1 produced meaningful excess power on the order of 50-60 watts and at meaningful temperatures 250-320 °C. The simulation model I developed attempts to recreate the heat loss profile of the isothermal cell in order to assess how much energy theoretically would be required to maintain the cell at any temperature level. I developed this method as a theoretical modeling method to cross-check the calibrations and excess energy results acheived by the experiments on the isothermal cell. Chapters 4 and 5 below provide the results of the simulation model as well as my insights and lessons learned from the exercise. In addition, I developed a comprehensive testing protocol which, if implemented, could conclusively prove the energy gain of the isothermal cell and provide additional documentation for its performance.

Chapter 4 - Analysis of Model Performance vs. Experimental Results

In order to model thermally the heatloss for the BLP Isothermal Calorimeter I used the data provided from the BLP Experiment 15.6 witnessed by AEI employees on May 3,1996. The method of operation of the Isothermal Cell is provided in Section 3.1. The experiment which we observed operated according to BLP's predictions, previous experiments and protocol. We were able to observe the results detailed in Appendix 9. A summary of that test has been provided on Table 4.1 below.

TABLE 4.1 - Isothermal Cell Results: May 3-4, 1996

TIME	CRITICA	L TEMPERA	TURES - oC	PRESS.	FILAMENT	HEATER	EXCESS
111111	CELL	ROOM	AT	MILLTORR	WATTS	WATTS	WATTS
10:45 AM	279.50	28.42	251.08	1150	0	96.99	0.01
10.407					0	97.07	-0.07
		•			0	97.32	-0.32
11:10 AM							
11:15 AM					_		
11:45 AM	285.09	28.04	257.05	1400	15	48.54	33.46
					15	48. 9 4	33.06
					15	49.26	32.74
11:50 AM							
12:05 PM							
12:15 PM	288.86	27.88	260.98	1400	25	16.23	55.77
					25	17.75	54.25
					25	17.78	54.22
12:20 PM							
2:10 PM					•		
2:15 PM	289.24	27.45	261.79	1700	35	5.73	56.27
2:25 PM					42	0.00	55.00







At approximately 2 A.M. on the morning of May 4, 1996 the filament inside the Isothermal Cell which we were testing burnt out. This caused a significant and dramatic fall in cell temperature. The Isothermal Cell at that point in the experiment was receiving all of its input power and cell heating from the tungsten filament and the associated heat of reaction from the believed Hydrocatalytic reduction of the hydrogen gas at the near vacuum pressure [1.2-1.7 torr] within the cell. Figure 4.1 on the following page illustrates the dramatic drop in cell temperaure which was observed when the filament ceased to operate. The intent of my simulation model was to develop mathematical formulae that could match the heat loss profile of the cell while it underwent this steady state cooling toward room temperature and also match in to the calibration tests conducted at the 260-320 °C temperature levels. I pursued this approach assuming simplistically that all significant heat loss was acheived via conduction [U*A*AT] and that radiative and convective heat losses from the Isothermal Cell were minimal. With this approach I was able to get an excellent correlation at the lower temperature regime of operation [≤160 °C - see Figure 4.2] with a good fit at the higher temperature profile [≥ 260-320 °C - see Figure 4.3].

From those two pieces of the model I was able to develop an estimate of the heat loss of the Isothermal Cell at its entire range of operation in the tests conducted by BLP. This data is summarized below on Table 4.2.

TABLE 4.2 - Isothermal Cell Heat Loss vs. Temperature*

Cell Temperature [°C]	Calculated Heat Loss [watts]
27	0.0
50	9.3
75	19.3
100	29.4
125	39.5
150	49.6
175	59.6
200	69.8
225	79.8 .
250	89.9
275	100.0
300	110.1
325	120.2

^{* -} assumes ambient temperature is 27 °C

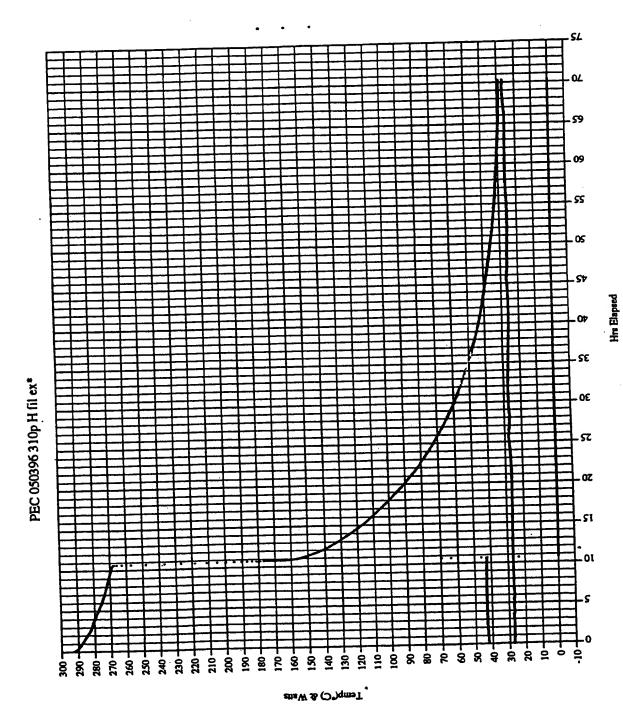




Peter Mark Jansson, P.P.,P.E. Page 54 of 73

FIGURE 4.1 - Isothermal Cell Performance - May 4, 1996

Room Temp Temp(*C) M. Cut.



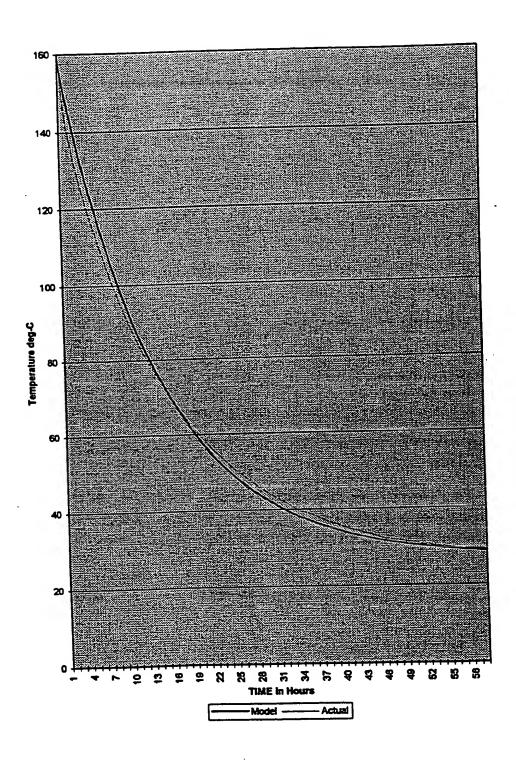




Peter Mark Jansson, P.P.,P.E. Page 55 of 73

FIGURE 4.2 - Isothermal Cell Model vs. Actual Heat Loss

Model vs. Actual Data





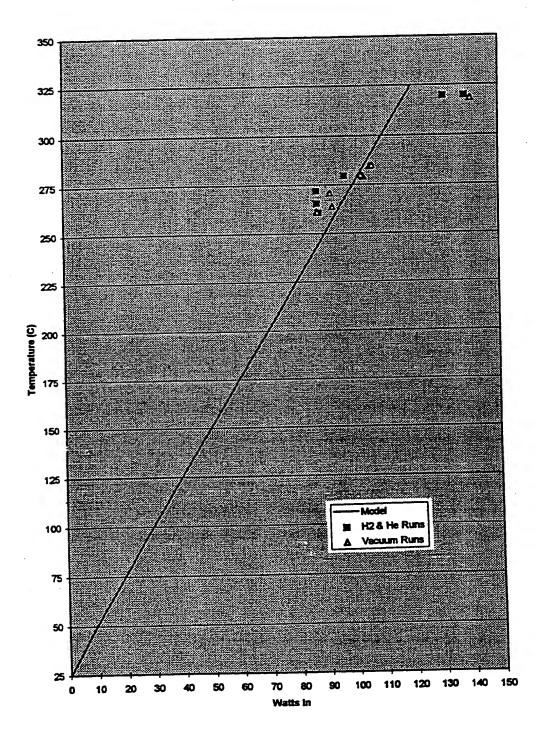




Peter Mark Jansson, P.P.,P.E. Page 56 of 73

FIGURE 4.3 - Isothermal Cell Heat Loss vs. Temperature

Isothermal Cell - Heat Loss







Chapter 5 - Key Learnings and Insights From Simulation and Model

What does all this modeling tell us? The specific experiment that we reviewed in order to develop the model can now be looked at with a greater degree of detail and understanding. We know that the Isothermal Cell was able to maintain a temperature measured by the thermocouple at between 280-290 °C. While under cartridge heater power it took 97-103 watts to maintain this temperature [our model says it should have taken approximately 102-106 watts]. When the hydrogen gas was exposed to the filament the thermocouple reading said that the temperature was maintained at approximately the same level. However, in this case the filament was using only 42 watts at steady state. If we were to estimate from the simulation model what the Isothermal Cell temperature would have to be in order for its steady state heat loss to be satisfied with only 42 watts of input power we would see that the equivalent temperature was 132 °C. It is hard to believe the cell was operating at this low of a temperature during the experiment since our heat loss model was well able to accurately track the heat loss of the cell from when the filament burnt out all the way up to 160 °C with an extremely high degree of accuracy. While these learnings indicate that the cell was in fact producing anomalous heat, it must be pointed out that due to cell variability observed between experimental runs and control runs and also between similar experiments the accuracy of heat measurement in the Isothermal Cell is not fully quantified and known. Due to the significant number of BLP experimental and control runs on their isothermal calorimeters the summary results highlighted in Table 3.1 it is most probable that the cell in fact produces heat consistently. Due to the variability of the few control studies that were run by BLP demonstrating that the Isothermal cell exhibits different behavior when it is operating on filament power versus cartridge heater power, more control studies are needed. As discussed in section 3.1 this researcher believes that some of the variability between cell heating source performance may be due to the four factors described in Section 3.1 [i.e.; the relative distances between the heating sources and the thermocouple, etc.] Nonetheless, it is important to note that this experiment does appear to create anomalous heat far beyond the cartridge/filament differential calculated by the control experiments. From the heat loss model described above it appears that this isothermal cells was able to create at least 10-30 watts of useful power even in its early development state.

Included on the pages that follow I have outlined a proposed testing protocol for the Isothermal Cells which I believe will conclusively demonstrate their performance or lack of performance. In that protocol I recommend that the isothermal cells be outfitted with external temperature measurement thermistors and that a full set of controls and experiments be carried out on these cells. From this work we can develop heat loss calibration curves under various temperature and pressure regimes. In addition, each cell should be blanketed with a standard jacket to reduce heat loss variability from experiment to experiment. From a very high temperature the cell should be turned off and a heat loss decay model be fit to its heat loss rate over time. This empirical model can then be used as a second source of validation for the calculated excess energy created in the hydrocatalytic reaction within the vessel.



ISOTHERMAL CALORIMETER

Definitive and Conclusive Testing Protocol

SETUP:

Develop and Install Standard Insulation Jacket [2-4" min. thickness] Install 2 Internal [Top and Bottom] Thermocouples and/or Thermistors Install 6 External Thermistors top, bottom, each 90 degrees alternate up down 1/3 Measure total weight, and total volume of isothermal vessel Develop computer controlled program to initiate steps 1-3 of each protocol

Control Run #1 - He at 1 atmosphere

1. Measure all relevant temperature, pressure parameters and time for following protocol:

USING ONLY CARTRIDGE HEATER

10 watts in for 1-4 hours or until steady state is achieved up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

> up power to 30 watts in [until steady state temps] up power to 40 watts in [until steady state temps] continue..... in 10 watt increments noting all temps and time up to 200 watts in or until cell temps are over 400 °C Shut off all power and monitor temperature decline vs. time

2. Measure all relevant temperature parameters and time for following protocol:

USING ONLY 200 CM. FILAMENT

10 watts in for 1-4 hours or until steady state is achieved

up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

up power to 30 watts in [until steady state temps]

up power to 40 watts in [until steady state temps]

continue..... in 10 watt increments noting all temps and time

up to 200 watts in or until cell temps are over 400 °C

Shut off all power and monitor temperature decline vs. time

3. Measure all relevant temperature parameters and time for following protocol:

USING FIRST CARTRIDGE HEATER FOR 10 WATTS THEN FILAMENT FOR NEXT 10 WATTS

10 watts in for 1-4 hours or until steady state is achieved up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

up power to 30 watts in [until steady state temps]







up power to 40 watts in [until steady state temps] continue..... in 10 watt increments noting all temps and time up to 200 watts in or until cell temps are over 400 °C

Control Run #2 - H2 at 1 atmosphere

1. Measure all relevant temperature parameters and time for following protocol:

USING ONLY CARTRIDGE HEATER

10 watts in for 1-4 hours or until steady state is achieved up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

up power to 30 watts in [until steady state temps] up power to 40 watts in [until steady state temps] continue..... in 10 watt increments noting all temps and time up to 200 watts in or until cell temps are over 400 °C Shut off all power and monitor temperature decline vs. time

2. Measure all relevant temperature parameters and time for following protocol:

USING ONLY 200 CM. FILAMENT

10 watts in for 1-4 hours or until steady state is achieved up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

up power to 30 watts in [until steady state temps] up power to 40 watts in [until steady state temps] continue..... in 10 watt increments noting all temps and time up to 200 watts in or until cell temps are over 400 °C Shut off all power and monitor temperature decline vs. time

3. Measure all relevant temperature parameters and time for following protocol:

USING FIRST CARTRIDGE HEATER FOR 10 WATTS THEN FILAMENT FOR NEXT 10 WATTS

10 watts in for 1-4 hours or until steady state is achieved up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

up power to 30 watts in [until steady state temps] up power to 40 watts in [until steady state temps] continue..... in 10 watt increments noting all temps and time up to 200 watts in or until cell temps are over 400 °C

Control Run #3 - He at 2 Torr

1. Measure all relevant temperature parameters and time for following protocol:







USING ONLY CARTRIDGE HEATER

10 watts in for 1-4 hours or until steady state is achieved up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

up power to 30 watts in [until steady state temps] up power to 40 watts in [until steady state temps] continue..... in 10 watt increments noting all temps and time up to 200 watts in or until cell temps are over 400 °C Shut off all power and monitor temperature decline vs. time

2. Measure all relevant temperature parameters and time for following protocol:

USING ONLY 200 CM. FILAMENT

10 watts in for 1-4 hours or until steady state is achieved up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

up power to 30 watts in [until steady state temps] up power to 40 watts in [until steady state temps] continue..... in 10 watt increments noting all temps and time up to 200 watts in or until cell temps are over 400 °C Shut off all power and monitor temperature decline vs. time

3. Measure all relevant temperature parameters and time for following protocol:

USING FIRST CARTRIDGE HEATER FOR 10 WATTS THEN FILAMENT FOR NEXT 10 WATTS

10 watts in for 1-4 hours or until steady state is achieved up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

up power to 30 watts in [until steady state temps] up power to 40 watts in [until steady state temps] continue..... in 10 watt increments noting all temps and time up to 200 watts in or until cell temps are over 400 °C

Control Run #4 - H₂ at 2 Torr

1. Measure all relevant temperature parameters and time for following protocol:

USING ONLY CARTRIDGE HEATER

10 watts in for 1-4 hours or until steady state is achieved up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

up power to 30 watts in [until steady state temps] up power to 40 watts in [until steady state temps]



Peter Mark Jansson, P.P.,P.E. Page 61 of 73

continue..... in 10 watt increments noting all temps and time up to 200 watts in or until cell temps are over 400 °C Shut off all power and monitor temperature decline vs. time

2. Measure all relevant temperature parameters and time for following protocol:

USING ONLY 200 CM. FILAMENT

10 watts in for 1-4 hours or until steady state is achieved up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

up power to 30 watts in [until steady state temps] up power to 40 watts in [until steady state temps] continue..... in 10 watt increments noting all temps and time up to 200 watts in or until cell temps are over 400 °C Shut off all power and monitor temperature decline vs. time

3. Measure all relevant temperature parameters and time for following protocol:

USING FIRST CARTRIDGE HEATER FOR 10 WATTS THEN FILAMENT FOR NEXT 10 WATTS

10 watts in for 1-4 hours or until steady state is achieved up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

up power to 30 watts in [until steady state temps] up power to 40 watts in [until steady state temps] continue..... in 10 watt increments noting all temps and time up to 200 watts in or until cell temps are over 400 °C

Control Run #5 - Near Vacuum [< 25 mTorr]

1. Measure all relevant temperature parameters and time for following protocol:

USING ONLY CARTRIDGE HEATER

10 watts in for 1-4 hours or until steady state is achieved up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

up power to 30 watts in [until steady state temps] up power to 40 watts in [until steady state temps] continue..... in 10 watt increments noting all temps and time up to 200 watts in or until cell temps are over 400 °C Shut off all power and monitor temperature decline vs. time

2. Measure all relevant temperature parameters and time for following protocol:

USING ONLY 200 CM. FILAMENT





Peter Mark Jansson, P.P.,P.E. Page 62 of 73

10 watts in for 1-4 hours or until steady state is achieved up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

up power to 30 watts in [until steady state temps] up power to 40 watts in [until steady state temps] continue..... in 10 watt increments noting all temps and time up to 200 watts in or until cell temps are over 400 °C Shut off all power and monitor temperature decline vs. time

3. Measure all relevant temperature parameters and time for following protocol:

USING FIRST CARTRIDGE HEATER FOR 10 WATTS THEN FILAMENT FOR NEXT 10 WATTS

10 watts in for 1-4 hours or until steady state is achieved up power to 20 watts in for another 1-4 hours or until steady state temperatures are reached

up power to 30 watts in [until steady state temps] up power to 40 watts in [until steady state temps] continue..... in 10 watt increments noting all temps and time up to 200 watts in or until cell temps are over 400 °C

Conduct Full Experiment Series

Repeat Series of Experiments [ie; 15.6, 15.9, 15.10, etc.] w/ 200 cm. filament to isolate optimal zones of operation for maximizing excess heat generation effect. Track power dissipation per surface area on filament.

Replace filament with tungsten of greater surface area. First increase diameters, then increase roughness. Assure 100% and 200-500% changes in area.

Increase total areas of tungsten filament in reactor vessel by 1000% via curled filament etc.

Use parameters above to design meaningful 1-5 kW water heater design and 1-20 kW space heater design





Peter Mark Jansson, P.P., P.E. Page 63 of 73

PART IV - Implications for the Future

The world energy market represents over 100 trillion kilowatthours of equivalent energy consumed each year and traded for well in excess of \$1 trillion. It is clear that the BLP process is in a very early stage of development and is not likely to impact this market in any significant way before the turn of the century. However, the experimental evidence reviewed and the data developed by this thesis indicates that there is an extremely high probability that the effect predicted by Dr. Mills' work in his unified field theory and the laboratory devices developed by William R. Good and his BLP associates in the laboratory may play a major role in the future of the energy industry. Gas and electrolytic phase cells and devices currently capable of releasing heat on the order of 1-20 times energy input show promise for significant technical expansion as more focus and scientific and engineering resources are brought to bear on the task. BlackLight Power currently raised over \$10M in additional investment through its final private placement offering which will make it possible for them to hire additional scientists and engineers for this very purpose. Across the world others are beginning to note with interest the reproducible and predictable production of anomalous heat via test cells that incorporate hydrogen and appropriate catalytic materials [see Table 6.1] While the "cold fusion scandal" has created a stigma which has made it difficult for the academic community to perform a complete and unbiased analysis of the claims the many researchers have made over the past few years, it appears clear that the dike holding this information back is about to burst. Table 6.1 is a brief snapshot of but a few claims that have been documented by credible scientists in industry and academia in the last few years.

TABLE 6.1 - Global Reports/Observations on BLP Technology

Journal	Observed Data / Reported Results*	Researcher(s) & Affiliation
FUSION TECHNOLOGY March 1997	2,500 times energy out of hydrogen, hydrogen is lost in reaction, new form of tightly bound hydrogen is the model proposed to explain energy and loss results	DuFour, Foos, Millot and DuFour of Shell Research/CNAM Laboratoire des Sciences Nucleaires, Paris, France
JOURNAL of ELECTRO- ANALYTICAL CHEMISTRY (1993) and (1991)	Significant heat production from electrolytic cells and the observation of a dideutrino molecule with a higher ionization energy similar to the Mills energy predictions	Miles, Bush, Lagowald, Ostrom and Miles of China Lake Naval Air Wartare Center Weapons Division, US
3rd Conference on Cold Fusion - October 1992	Significant excess heat production from cell with mass spec data indicating a diductrino molecute [i.e.; lower energy deuterium molecute via Mills]	Yamaguchi and Nishioka of the NTT Basic Research Laboratories and IMRA Europe S.A.
• - see footnotes 39 - 4:	3	





Peter Mark Jansson, P.P., P.E. Page 64 of 73

Within the next five years there will be a significant increase in awareness of the factual information surrounding the experiments conducted by many on hydrogen technologies which are taking advantage of the natural effect first observed by Dr. Mills. The data provided in this thesis is but a brief summary of the wealth of work that has already been performed in this area of science. Most academicians I have spoken with regarding the work of Dr. Mills and Mr. William Good are annoyingly critical and pessimistic before even asking to hear the details of their experiments or supporting data. It does not surprise this researcher that it has taken at least five years for Dr. Mills work to begin to gain the recognition that it needs to have for appropriate peer review and true academic critique. It is hoped that this thesis work will draw attention to the need for a balanced and open debate on the legitimacy of the BLP claims, which though they seem extensive are also grounded in excellent technical and theoretical research.

Chapter 6 - Implications for the Future and Recommended Next Steps

A new energy paradigm will not be quickly embraced by those currently in decision-making positions in the energy industry. Literally trillions of dollars have been invested over the past fifty years in the current energy infrastructure and its early retirement could cause major economic disruption. However, the deregulation of the gas industry over the past decade combined with the current efforts to deregulate the electric industry have positioned at least the U.S. and much of the U.K. energy industry for the major competitive forces and shifts that the introduction of a new technology like BLP would cause. Cogeneration and independent power producer competition have already ushered in the pre-competitive era for most in the electric industry while the gas, oil and other traded energy commodities have been fiercely competitive for some time. Nonetheless, there is little to gain for the established energy providers to accelerate the adoption of a new energy technology based upon hydrogen. Adopting a 'wait and see' strategy not only minimizes the risk of embarrassment should the technology prove to have little commercial potential, but also could stall or delay the day when the technology is ready and able to compete directly with the energy providers for their customers. History has shown that only a few in business adopt the Peter F. Drucker strategy of creating their future. [Drucker quote; "The only way to control the future is to create it"] Most are content to watch it being created around them and then getting involved once it is clear what the winning technologies are likely to be. In the case of a paradigm shift as radical as the one proposed by Dr. Mills and BLP, waiting could be a devastating business strategy. This researcher has advised his energy company to become involved from the beginning and other companies should also follow this advice. Knowing how quickly the technology may develop and emerge best positions the energy company to plan for the timely deployment, divestiture and or disposition of its assets that may be most at risk should commercialization move on a fast or slower track. This closing section of my thesis however, is not dedicated to what the energy industry should do as next steps but rather to what BLP should do in the near future to solidify their position with this technology and maximize the benefits for their shareholders for the investment







Peter Mark Jansson, P.P.,P.E. Page 65 of 73

they have made in developing this technology. The following list of recommended next steps is brief and succinct, but should assure BLP success in their endeavors if completed in a timely manner.

Recommended Next Steps

- 1. Clarify the Vision, Mission and Purpose of BlackLight Power, Inc. and communicate it clearly to all employees, contractors and owners. Align all corporate and employee goals and compensation strategies with the attainment of these. Identify the corporate competencies needed to execute the goals and mission of organization.
- 2. Focus on maximizing the intellectual property developed, owned and applied by BLP employees [individually and as a group]. Maximize new patent filings for all supportive device technologies and innovations. [If overarching patents fail, supporting patents will still protect the embodiments of the BLP effect in most apparata] Maximize the technical and journal papers published and defended during years 1-5.
- Focus on Communicating the BLP Vision, Mission and Purpose to all appropriate audiences and keep an adequate supply of current, accurate and appropriate information flowing to the media and necessary constituents.
- 4. Focus on Identifying and Quantifying the Key Parameters controlling the Hydrocatalysis and Disproportionation effects including the isolated optimization of each as well as their interactions with each other. [ie; dissociation surface area, partial pressures -catalyst vs. hydrogen atoms, mean free paths, temperature regimes, volumetric proportionalities, time dependence, etc.] This should be completed for all key embodiments gas phase, electrolytic phase, etc.
- Develop a self-contained, self-sustaining "Hot Black Box" which irrefutably demonstrates the ability that BLP has to control all key parameters and engineer the optimization of the effect for commercial application and manufacturing. This must not be left to others to develop, it should be the work and competence of BLP at the end of the day in order to maintain a competitive advantage in this field.
- 6. Develop the BLP management model and compensation strategy. Hire sufficient numbers of management and staff with the necessary competencies to successfully execute items 1-5 during the first 18 months after sufficient funding is achieved.



\$

Master of Science in Engineering Thesis Rowan University

Peter Mark Jansson, P.P.,P.E. Page 66 of 73

PART V - Reference Materials

The data reviewed in this thesis was substantial and unfortunately only a brief overview was able to be provided in the limited space. Many items referenced can be easily obtained from the author or from a librarian. This section is devoted to making that exercise more simple. The reference materials have been divided into two sections. First, a straightforward list of all Footnotes cited in the text grouped by their section or subsection number is available on the next three pages. Second, where key information was substantial and of primary relevance to the thesis but could not be afforded adequate coverage in the text, Appendices were developed to provide the needed reference support. Placing them at the end of this thesis allowed the continuity of idea flow without distracting the reader from the key points being made. The full list of relevant supporting appendices is shown on the page before they begin as the final page in Part V.

References Provided in this Thesis

Footnotes

Pages 67-71

Description of Appendices

Pages 72-73

Full Appendices Follow



THESIS FOOTNOTES [continued]

PART I. Chapter 1. Section 1.1 - Fossil Fuels [continued]

- Nesbit, William, "World Energy- Will There Be Enough in 2020?",
 Decisionmakers Bookshelf, Vol. 6, Edison Electric Institute, © 1979, ISBN 0-931032-06-7
- 11 Kraushaar, Jack J., Ristinen, Robert A., "Energy and Problems of a Technical Society", 2nd Edition, John J. Wiley & Sons, Inc., © 1984, 1993, ISBN 0-471-57310-8, Figure 1.15, p. 21
- 12 "World Book Encyclopedia J-K", Field Enterprises Educational Corporation, © 1961, Library of Congress Cat. No. 61-5169, p. 32a
- Weinfeld, Steven G., "Funk & Wagnalls New Encyclopedia Volume 14", Funk & Wagnalls, ©1986, Library of Congress Cat. No. 72-170933, ISBN 0-8343-0072-9, p. 402
- Kraushaar, Jack J., Ristinen, Robert A., "Energy and Problems of a Technical Society", 2nd Edition, John J. Wiley & Sons, Inc., © 1984, 1993, ISBN 0-471-57310-8, pp. 2-3

PART I. Chapter 1. Section 1.2 - Nuclear Energy - Fission & Fusion

- 15 Schwarzchild, B., Physics Today, October 1990, pp. 17-20
- Kraushaar, Jack J., Ristinen, Robert A., "Energy and Problems of a Technical Society", 2nd Edition, John J. Wiley & Sons, Inc., © 1984, 1993, ISBN 0-471-57310-8, pp. 108-111
- Associated Press, "Princeton reactor's closure casts doubt on fusion prospects", The Press of Atlantic City, March 30, 1997
- Kraushaar, Jack J., Ristinen, Robert A., "Energy and Problems of a Technical Society", 2nd Edition, John J. Wiley & Sons, Inc., © 1984, 1993, ISBN 0-471-57310-8, Table 4.1, p. 95
- 19 "Barsebick to Close Down by 2001", The Swedish Press, March 1997, p. 9









Peter Mark Jansson, P.P., P.E. Page 69 of 73

THESIS FOOTNOTES [continued]

PART I. Chapter 1. Section 1.3 - Solar Energy

- Energy Info Home Page, http://www.energyinfo.co.uk:80/wstats.html, World Fuel Consumption by Country, pp. 1-2, ©1996 by EnergyInfo, last modified April 26, 1996
- U.S. Census Bureau World POPClock Web Page, http://www.census.gov/cgi-bin/ ipc/popclockw, International Programs Center, World Population projected to 2/24/97 at 7:09:44 PM EST
- Energy Info Home Page, http://www.energyinfo.co.uk:80/wstats.html, World Fuel Consumption by Country, pp. 1-2, ©1996 by EnergyInfo, last modified April 26, 1996
- P.M. Jansson and R.A. Michelfelder, "Market-Driven Photovoltaic System Economics for Grid-Connected Residential and Commercial Customers", 14th European Photovoltaic Solar Energy Conference, Barcelona, Spain, June 30 July 4, 1997

PART I. Chapter 1. Section 1.4 - Geothermal Energy

24 Kraushaar, Jack J., Ristinen, Robert A., "Energy and Problems of a Technical Society", 2nd Edition, John J. Wiley & Sons, Inc., © 1984, 1993, ISBN 0-471-57310-8, p. 204

PART I. Chapter 1. Section 1.5 - Tidal Energy

Kraushaar, Jack J., Ristinen, Robert A., "Energy and Problems of a Technical Society", 2nd Edition, John J. Wiley & Sons, Inc., © 1984, 1993, ISBN 0-471-57310-8, p. 210, Table 7.8

PART I. Chapter 2. Section 2.1 - Theoretical Description

- Mills, Randell L., "The Grand Unified Theory of Classical Quantum Mechanics", Black Light Power, © September 1996, Library of Congress Cat. No. 96-70686, ISBN 0-9635171-2-0, p. x
- Mills, Randell L., "The Grand Unified Theory of Classical Quantum Mechanics", Black Light Power, © September 1996, Library of Congress Cat. No. 96-70686, ISBN 0-9635171-2-0, p. 138





Peter Mark Jansson, P.P.,P.E. Page 70 of 73

THESIS FOOTNOTES [continued]

PART I. Chapter 2. Section 2.2 - Astrophysical Corroboration

- Labov, S.E., Bowyer, S., "Spectral Observations of the Extreme Ultraviolet Background", The Astrophysical Journal, 371:810-819 © 20 April 1991, The American Astronomical Society
- 29 Schwarzchild, B., Physics Today, October 1990, pp. 17-20
- Bahcall, J., et. al., "Solar neutrinos: a field in transition", Nature, 334, 11 1988, pp. 487-493
- 31 Taubes, G., Science, 256, 1992, pp. 1512-1513
- 32 Taubes, G. Science, 256, 1992, pp. 731-733

PART I. Chapter 2. Section 2.3 - Enigmas Solved

- Mills, Randell L., "The Grand Unified Theory of Classical Quantum Mechanics", Black Light Power, © September 1996, Library of Congress Cat. No. 96-70686, ISBN 0-9635171-2-0, p. 426
- Phillips, Kenneth J.H., "Guide to the Sun", Cambridge University Press, © 1992, ISBN 0-521-39483, p. 166
- Phillips, Kenneth J.H., "Guide to the Sun", Cambridge University Press, © 1992, ISBN 0-521-39483, p. 367
- Chown, Marcus, "Dark matter is still the only game in town", New Scientist, January 7, 1995, p. 15

PART II. Chapter 4

DuFour, J., Foos, J., Millot, J.P., DuFour, X., "Interaction of Palladium / Hydrogen and Palladium / Deuterium to Measure the Excess Energy Per Atom for Each Isotope", Fusion Technology, Volume 31, March 1997, pp 198-209

PART II. Chapter 4. Section 4.2 - Penn State University Calvet

Phillips, Jonathan, "Report on Calorimetric Investigations of Gas-Phase Catalyzed Hydrino Formation", Department of Chemical Engineering, Penn State University, Final Report for period of October - December 1996, p. 1







Peter Mark Jansson, P.P., P.E. Page 71 of 73

THESIS FOOTNOTES [continued]

PART IV

- DuFour, J., Foos, J., Millot, J.P., DuFour, X., "Interaction of Palladium / Hydrogen and Palladium / Deuterium to Measure the Excess Energy Per Atom for Each Isotope", Fusion Technology, Volume 31, March 1997, pp 198-209
- Miles, M.H., Bush B.F., Ostrom, G.S., Lagowski, J.J., "Helium Production During the Electrolysis of D₂O in Cold Fusion Experiments", Journal of Electroanalytical Chemistry, 301, p. 271 (1991)
- Miles, M.H., Hollins, R.A., Bush B.F., Lagowski, J.J., Miles, R.E.J., "Correlation of Excess Power and Helium Production During D₂O and H₂O Electrolysis using Palladium Cathodes", Journal of Electroanalytical Chemistry, 346, p. 99 (1993)
- Notoya, R. and M. Enyo, "Proceedings of the Third Annual Conference on Cold Fusion, Nagoya, Japan" October 21-25, 1992, H. Ikegami, Editor, Universal Academy Press, Inc., Tokyo, ©1992, pp. 421-426
- Yamaguchi, E. and Nishioka, T., "Direct Evidence for Nuclear Fusion Reactions in Deuterated Palladium", Proceedings of the Third Annual Conference on Cold Fusion, Nagoya, Japan, October 21-25, 1992, p. 179



Peter Mark Jansson, P.P.,P.E. Page 72 of 73

DESCRIPTION OF APPENDICES

Appendix 1. BLP Research Partners - Catalogue of Experimental Results
This researcher compiled a log of numerous experiments and studies that had been performed on BLP technologies over the past 5 years. These are summarized by title, author, report name, date of work and subject matter in this appendix.

Appendix 2. An Overview of Mills Theory

The theory of Dr Mills is rather complex in that it unifies all of the aspects of a new classical quantum mechanics, Maxwell's Equations, Einstein's Special and General Relativity as well as the fundamental classical theories and models of physics. A more full description of his theory is provided in this appendix.

Appendix 3. Jansson Astrophysical Data Calculations Verifying BLP Reported Results

Specific calculations provided by Dr. Mills in his text as part of demonstrating that data being collected from space is able to validate that the theoretical results of his model are sound have been made by this author. The Excel spreadsheet has produced the tables found in this appendix.

Appendix 4. BLP/AEI Experiment 15.6 - May 1996

Atlantic Energy witnessed testing of the Isothermal Cell at the BLP Laboratories in Malvern, Pa. On May 4-6, 1997. The actual lab notes from that experiment and associated calculations done by Atlantic Energy staff to verify the results observed are provided in this appendix

Appendix 5. Analysis of BLP Isothermal Calorimetry Data

Analysis of the Isothermal cell experiments was conducted by this researcher to see if the results that were being observed were consistent with heat loss modeling estimates. The actual data provided by the BLP data logger was reviewed to see if excess heat of formation was actually occurring. This appendix summarizes these results.

Appendix 6. PSU Calvet Test Results and Report - December 1996

This appendix contains the full research report completed by Pennsylvania State University on their tests of the BlackLight technology via a Calvet calorimeter.

Appendix 7. Jansson Calvet Testing Protocol

This appendix describes the protocol that was used in the control and experimental runs performed in BlackLight Power's laboratory facility during February through May 1997 by Peter Mark Jansson., P.P., P.E.





Peter Mark Jansson, P.P., P.E. Page 73 of 73

DESCRIPTION OF APPENDICES [continued]

Appendix 8. Jansson Calvet Test Results June 1997

The results of the experimental and control runs are provided in more detail in this appendix. While the Lab Note Book has not been included each day of experiments that were analyzed in the summary data provided in the thesis are shown explicitly. Each data set name is listed as well.

Appendix 9. Jansson Heat Loss Model Calibration & Performance

Specific mathematical modeling of the Isothermal cell was developed by this researcher to see if the results that were being observed were consistent with those that a heat loss model could predict. The calibration of the model was made via actual data provided by the BLP data logger and produced results which indicated excess heat of formation was actually occurring. This appendix summarizes these results.







.......

bearing

was remain

poster posterio

THESIS - APPENDIX ONE









Peter Mark Jansson, P.P.,P.E. Appendix 1

Appendix 1 - Catalogue of Relevant Publications and Experimental Results

This appendix provides a brief overview of relevant publications and printed experimental results that this researcher was able to acquire, review and summarize. I have not made an exhaustive search for electrolytic cell experimental data since it is extremely lengthy. The catalogue begins on the page which follows and forms the essence of this appendix.







¥
2
≅
텵
ᅙ
Ę
ĕ
印
P
8
5
.# #
粪
Ę
Ξ
툫
岩
Ř
ö.
ě
8
ata
Ü
.≚
nd
ğ
¥

	Purpose/Resuns/conclusions	Independent Technology Assessment	Presentation and Defense of Theory w/ Experiments	Presentation and Defense of Theory	Experimental Electrolytc Cell Results	Experimental Electrolytc Cell Results Dihydrino Identification	Experimental Electrolytc Cell Results Hydrino and Dihydrino identification
	Publication Status	PC - Confidential presented to Pacificorp printed 30 August 1996	BlackLight Power published September 1996	Science Press published 1989	Fusion Technology Vol 20., 65-81 published 1991	Fusion Technology Vol 25., 103 published 1994	Fusion Technology Vol 28., 1697-1719 published 1995
Appendix 1 - Catalogue (1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	Paper/Report - Author	HydroCatalysis Technical Assessment TECHNOLOGY INSIGHT8 San Diego, CA 619-455-9500	The Grand Unified Theory of Classical Quantum Mechanics R.L. Mills BLACKLIGHT POWER CORP Malvem, PA 610-651-4938	The Grand Unified Theory R.L. Mills and J.J. Farrell HYDROCATALYSIS POWER CORP Malvem, PA 610-651-4938	Excess Heat Production by the Electrolysis of an Aqueous Potassium Carbonate Electrolyte and the Implications for Cold Fusion R.L. Mills and S.P. Kneizys HYDROCATALYSIS POWER CORP Malven, PA 610-651-4938	Dihydrino Molecule Identification R.L. Mills, W.R. Good and R.M. Schaubach* HYDROCATALYSIS POWER CORP Malvem, PA 610-651-4938 •- of THERMACORE, INC.	Fractional Quantum Energy Levels of Hydrogen R.L. Mills and W.R. Good HYDROCATALYSIS POWER CORP. Malvem, PA 610-651-4938





Appendix 1 - Catalogue of Relevant Publications and Experimental Results

SBIR Phase I Project Report 11-1124 published March 1994 PSU -Confidential presented to BLP prepared 1994 PSU - Confidential presented to BLP prepared 1994 PSU - Confidential presented to BLP prepared 1996 prepared 1996	Paper/Report - Author Nascent Hydrogen an Energy Source N.J. Gernhart, R.M. Schaubach WRIGHT PATTERSON - AFB Makem, PA 610-651-4938 Report on Calorimetric Investigations of Gas- Phase Catalyzed Hydrino Formation S. Kurtz, J. Phillips and J. Smith Penn State Univ., PA 814-893-4809 A Calorimetric Investigation of the Reaction of Hydrogen with Sample PSU #1 M.C. Bradford and J. Phillips Penn State Univ., PA 814-863-4809 Additional Calorimetric Examples of Anomalous Heat from Mixture of K/Carbon and Pd/Carbon J. Phillips and Shim, H. Penn State Univ., PA 814-863-4809 Additional Examples of Anomalous Heat: Hydrogen Mass Balance J. Phillips Penn State Univ., PA 814-863-4809
	January State Univ PA 814-863-4809
	4dditional Examples of Anomalous Heat: Hydrogel Vass Balance Desilino
PSU - Confidential Penn State Spillover Catalyst Calvet Calorimetry presented to BLP prepared 1996	Additional Calorimetric Examples of Anomalous feat from Mixture of K/Carbon and Pd/Carbon Phillips and Shim, H.
PSU -Confidential Penn State Solid Oxide Catalyst Calvet Calorimetry presented to BLP prepared 1994	#1
PSU -Confidential Penn State Gas Phase Calvet Calorimetry presented to BLP prepared December 1996	eport on Calorlmetric Investigations of Gashase Catalyzed Hydrino Formation . Kurtz, J. Phillips and J. Smith em State Univ., PA 814-883-4809
	ergy So ach
	aper/Report - Author





Appendix 1 - Catalogue of Relevant Publications and Experimental Results

D. L. Handler Ct.	Lubilcadon Su	
	or	1
	Sanar/Renort - Auth	a Politica Principal

Westinghouse STC Report prepared 25 February 1994	M.I.T. Lincoln Labs Meeting Viewgraphs
Evaluation of Heat Production from Light Water Electrolysis Cells of HydroCatalysis Power Corp. S.H. Peterson	Excess Energy Cell Final Report

Chemical Engineering Branch printed June 1994

Proprietary/EPRI AECL Research

O
ō
≆
➣
ø
₹.
ğ
프
ш
₩
J
c
త్తి
泵
ď
≆
Ñ
9
~
=
•
9
ನ
Ĕ
0
⊆
풒
ä
≶
>

Purpose/Results/Conclusions

on.
8
Ō.
7
¥
좆
ĸ
ট্
흳
m
ਨ
ž
₫
98
뚫
ö
≥
=
ഉ
3
2
a
.⊆
क
9
5

_
뽘
<u> </u>
ď
=
3
Ą
ਰਿ
ঠ
- W
물
ᅙ
듣
8
面
9
鱼
7
র
_ ≧
느
Ξ

93
₹
ᇙ
9
Œ
=
ጸ
_
2
جے
2
퓲
ē
面
=
20
듩
z
-⊊
6
9-
ាភ
ш

Meeting Viewgraphs printed / reviewed 1995

as of: 31 May 1997









THESIS - APPENDIX TWO

province browning brokers as

and weekly account

actions actions

27.00.00









Peter Mark Jansson, P.P., P.E. Appendix 2

Appendix 2 - An Overview of Mills Theory

The section which follows is but a brief description of a theory that has clearly been years of development work on the part of Dr. Randell Mills. I refer the reader to his complete text on "The Grand Unified Theory of Classical Quantum Mechanics". Dr. Randell Mills received his BA in Chemistry from Franklin & Marshall College in 1982 where he graduated summa cum laude. He went on to graduate from Harvard Medical School receiving his MD in 1986 while simultaneously developing his theoretical model for unification while taking electrical engineering courses at M.I.T. He is the creator and owner of many medical patents and the recipient of many academic awards. He has published many technical papers and presented his Grand Unified Theory in 1989. The following year [1990] he went on to form the HydroCatalysis Power Corporation [now BlackLight Power]. Since that time he has been demonstrating the proof of his theory by using it to design devices that use proprietary catalysts to reduce hydrogen to the lower energy states predicted by his model of the hydrogen atom. This he has done successfully in many types of apparata. Concurrently he has filed patents in the U.S. and 23 foreign countries. A patent was awarded in Australia in 1996.

Dr. Mills is President of BlackLight Power [BLP]. presently a small, high technology firm and laboratory located in Malvem, Pennsylvania. It is a privately held company with numerous entrepreneurial investors but has at least two major utility owners [Pacificorp from the western U.S. and Atlantic Energy from the eastern U.S.] BLP is currently being courted by additional U.S. utilities and major U.S. energy equipment manufacturers. While significant data and experiments conducted by BLP and others appear to demonstrate conclusively the reproducibility of their new heat generation effects it would seem that the timing of their discovery was not conducive to its being objectively reviewed and granted widespread academic review for authenticity. The 1990-1991 debunking of "cold fusion" and the sharp criticism that still comes to scientists and academicians who research these claims has placed a cold, wet blanket on the hot findings that continue to be generated by the scientific team from BLP. This researcher believes that the "Pons and Fleischmann experience" has increased resistance in the academic community to objective investigation of the BLP findings and claims.

Table 2.1 in the thesis text summarizes the significant government, corporate and university research centers that have corroborated BLP's findings. At the present time the company's Board has voted to allow only one more private offering before an independent public offering planned sometime in the next 1 to 2 years. To date it is important to note that the work developed by BLP has been primarily funded by its investors with limited government research funding. The total effort to bring the company to its current state of technological development has cost its private owners less than a few million dollars over the past seven years. This needs to be contrasted with the billion dollar expenditures over the past few decades for particle accelerators, nuclear research and investigations into the claims of cold fusion.





Peter Mark Jansson, P.P.,P.E. Appendix 2

To Dr. Mills' credit his theory holds at its foundations inviolate the classical laws of physics, including all of those listed below:

- 11 Conservation of mass-energy
- 2) Conservation of Linear and Angular Momentum
- 3] Maxwell's Equations on Electromagnetics
- 4] Newton's Laws of Mechanics
- 5] Einstein's General Relativity
- 61 Einstein's Special Relativity

His theory produces the same equation for the principle energy levels of the hydrogen atom as both Bohr and Schrodinger but only Mills theory gets there through a derivation from first principles. Bohr's model [1913] represented the electron as a point particle whose circular orbit around the nucleus of the hydrogen atom was mainatained by a perfect balancing of the coulombic force of attraction [positive proton nucleus (e*) and negative electron (e*) satelite] between the two particles and the cetrifugal force of the electron. However, the non-radiation of the electron charge at such an orbit velocity led to this postulation being in defiance of Maxwell's Equations on electromagnetics. While "his model was in agreement with the observed hydrogen spectrum it failed for the helium spectrum and could not account for chemical bonds in molecules." All Schrodinger's model [1926] was a totally mathematical view of the electron which he developed based upon de Broglie's wave postulate for electron motion. His famous wave equation has an infinite number of ways in which it can be solved. In order to create a solution for the electron he applied a boundary condition which in essence stated that as the radius of the electron's orbit approaches infinity [r -> ∞] his wave function approaches zero $[\Psi \rightarrow 0]$. The problems of creating a classical or physical interpretation of Schrodinger's wave equation have been significant over the years and so, as a result, physicists have drifted more and more to a purely mathematical view of the interaction of physics at the atomic level, with no adequate physical description of particle behavior. This has set up a duality in the application of the laws of physics. The classical laws are used at the macro level but at the micro level probability and statistics reign. "According to the Copenhagen interpretation, every observable state exists in a state of superposition of possible states and observation or the potential for knowledge causes the wavefunction corresponding to the possibilities to collapse into a definite state **A2 It was these difficulties in the accepted physics of quantum mechanics that led Dr. Mills to seek an alternative. Through his theory, he sought physical laws which were exact on all spatial scales. Dr. Mills did not give the electron the wave nature adopted by Schrodinger and suggested by de Broglie and the Davisson-Germer experiment but developed closed-form calculations that use only the fundamental constants of physics already accepted and understood that predict these aspects of the electron.

Table A.1 below outlines the aspects of physics which Dr. Mills' theory can directly calculate with its closed form equations.





Peter Mark Jansson, P.P., P.E. Appendix 2

TABLE A.1 - Mills' Theory Predictions

one electron atom w/ 4 quantum numbers
the Rydberg constant
the ionization energies of 1,2 & 3 electron atoms
equation of the electron in free space
electron g factor
excited states of the electron
parameters of pair production
bond energies, vibrational energies, rotational
energies and bond distances of hydrogen
-type molecules and molecular ions
equation of the expansion of the universe
the masses of atomic particles [leptons,
quarks and nucleons]
beta decay energy of the neutron
theory of alpha decay

spin/nuclear hyperfine structure
the stability of atoms
equation of the photon
results of Stern-Gerlach experiment
spin angular momentum energies
results of the Davisson-Germer experiment
hyperfine structure interval of positronium
Quantum Hall effects
the Aharonov-Bohm effect
equations of gravitation
the gravitational constant
the basis for the antigravitational force
magnetic moments of nucleons
the binding energy of deuterium
the chemical bond energies of molecules

Mills theory begins with the classical, fundamental laws of physics [see 1-6 above] and then applies a boundary condition on the electron significantly different than Schrdinger. His boundary condition is that a bound electron can not radiate energy at 13.6 eV. "The mathematical formulation for zero radiation is that the function that describes the motion of the electron must not possess spacetime Fourier components that are synchronous with waves traveling at the speed of light. The permissible solutions for the electron function are derived as a boundary value problem with the application of the nonradiative boundary condition. By using only the classical laws of physics, mathematics and this one new boundary condition [NOTE: this boundary condition is essentially required to satisfy Maxwell's equations] a totally new view of the electron emerges. The result of this theory by Dr. Mills also leads to the unification of all of the standard classical laws of physics. These can be solved mathematically, discretely and without the need to resort to the arbitrary gauging constants developed by presently accepted quantum theory in order to "get the theory to fit" observed data. Dr. Mills calls this new electron perspective and new classical view an electron orbitsphere. The orbitsphere solution to the electron's mathematical function produces many interesting features some of which are highlighted in Table 2.3 below. For a complete summary of the features described by Mills' theory the reader is referred to pages 22-26 of Dr. Mills' text.





Peter Mark Jansson, P.P., P.E. Appendix 2

TABLE A.2 - The Electron Orbitsphere

- bound electron orbitspheres are described completely by a charge-density [mass-density] function that can exist only at specified distances from the nucleus
- the function which totally describes an electron orbitsphere's motion is composed of two functions 1] a spin function and 2] a modulation function
- electron orbitsphere radii are calculated by setting its centripetal force equal to the electric and magnetic forces of the orbitsphere
- the electron orbitsphere behaves like a resonator cavity capable of absorbing photons of discrete frequencies [solutions to Maxwell's equations for excitation modes in this cavity give rise to four quantum numbers]
- excited electron orbitsphere states are unstable because the incoming photon disturbs the chargedensity function creating a doublet function that has spacetime Fourier components synchronous with waves travelling at the speed of light, thus it is radiative

the photon is an orbitsphere with electric and magnetic field lines along orthogonal great circles

when an electron orbitsphere is ionized its radius goes to infinity and it becomes a plane wave

atom's energy is stored in their electric and magnetic fields, chemical bonding occurs when the total energy of the atoms can be lowered by forming equipotential orbitals with geodesic motion and the nonradiative boundary condition can be met

lower electronic states exist below *conventional* [n = 1] ground state, hydrogen atoms can react with a catalyst having a net enthalpy of 27 eV inducing them to electronically relax and decrease their radii with the emission of electromagnetic energy consistent with each of their change in total energy state [ie; electric and magnetic field energies]

This thesis will not review the many mathematical formulations and proof calculations of Mills theory which is fully elaborated in his text. However the following illustrations may help the reader grasp more succinctly the new orbitsphere model proposed by Mills. Figures A.1 and A.2 below represents a physical view of Mills' model of the electron orbitsphere a spinning, two-dimensional spherical surface.

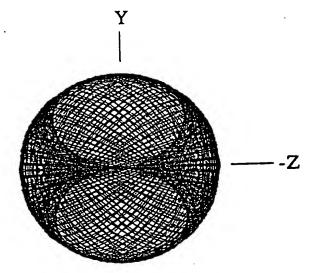




Peter Mark Jansson, P.P., P.E. Appendix 2

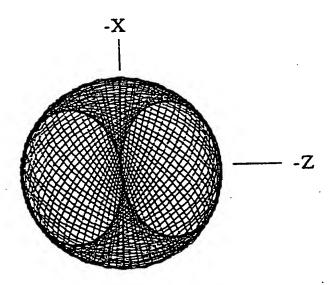
FIGURE A.1

Figure 1.4 B. The current pattern of the orbitsphere shown with 8.49 degree increments of the infinitesimal angular variable $\Delta\alpha(\Delta\alpha')$ from the perspective of looking along the x axis.



VIEW ALONG THE +X AXIS

Figure 1.4 C. The current pattern of the orbitsphere shown with 8.49 degree increments of the infinitesimal angular variable $\Delta\alpha(\Delta\alpha')$ from perspective of looking along the y axis.



VIEW ALONG THE Y AXIS

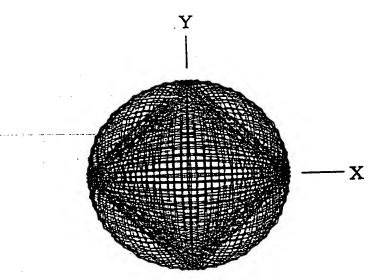




Peter Mark Jansson, P.P., P.E. Appendix 2

FIGURE A.2

Figure 1.4 A. The current pattern of the orbitsphere shown with 8.49 degree increments of the infinitesimal angular variable $\Delta\alpha(\Delta\alpha')$ from the perspective of looking along the z axis.



VIEW ALONG THE Z AXIS





Peter Mark Jansson, P.P., P.E. Appendix 2

In closing this overview of Mills' theory it is important to note that while the scientific community has been searching for a more classical unified field theory that could stand up to rigorous mathematical scrutiny for some time, there has not yet been a widepread review of his work by academia. The few academic reviews that have ben made on the merits, potential flaws or criticisms of Mills' work have come out glowingly in favor of his findings. This researcher believes that because Dr. Mills' is an outsider and not considered an expert in these fields that it will take much longer for his work to be widely discussed in academic circles. Mills theory is compelling and may offer just what Albert Einstein was looking for when he uttered his famous words denouncing the then emerging quantum theory "God does not play dice with the universe".

APPENDIX 2 FOOTNOTES

- [A1] Mills, Randell L., "The Grand Unified Theory of Classical Quantum Mechanics", BlackLight Power, © September 1996, Library of Congress Cat. No. 96-70686, ISBN 0-9635171-2-0, p. 7
- [A2] Mills, Randell L., "The Grand Unified Theory of Classical Quantum Mechanics", BlackLight Power, © September 1996, Library of Congress Cat. No. 96-70686, ISBN 0-9635171-2-0, p. 9
- [A3] Mills, Randell L., "The Grand Unified Theory of Classical Quantum Mechanics", BlackLight Power, © September 1996, Library of Congress Cat. No. 96-70686, ISBN 0-9635171-2-0, p. 22







D.A. TANKA

Assessions of a second

Presentión



THESIS - APPENDIX THREE









Mills Prediction vs. Data

	T _R	aw Extrem	e UV Back	ground Sp	pectral Dat	a •			
	OBSERVED		ſ	ractional	State	MILLS PRE			
		Energy	Calc	nf	ni	WaveInth	Energy		
	A	eV	eV			Α	eV		<u> </u>
Peak	84.8	146.2	146.2	8	7	82.9	149.6		
1		122.2	122.2	7	6	101.3	122.4		
2	101.5	106.2	106.2	4	2	114.0	108.8		
3	116.8	95.6	95.7		5	130.2	95.2		
4	129.6	88.8	88.8	4	2	141.6	87.6	He scattered	
5	139.6	75.9	76.0	8	7	165.8	74.8	2nd order Peak	1
6		68.3	68.2	5	4	182.3	68.0		
7		61.8	61.8	7	6	202.6	61.2	2nd order Peak	2
8		53.0	53.0	3	1	227.9	54.4		
9			47.5	5	4	265.0	46.8	He scattered	
10		47.5	41.0	4	3	303.9	40.8		
11		41.0	27.0	3	1	455.9	27.2	2nd order Peal	9
12		27.0	21.2			584.9	21.2	Helium Resona	ince
13		21.2		4	3	607.8	20.4	2nd order Peal	c 11
14		20.4	20.4	4	3	633.0	19.6	He scattered	
15		19.7	19.6	3	2	911.7			
16	5				-				
				1.60E-19	6.63E-34	3.00E+08			
				eV	h	C			
				- ev		 			
		David Forter	ma IIV Sal	ar Spectra	Data **	 			
			MILLS PR	FDICTED	T				
<u> </u>	OBSERVE	O-M	WaveInth						
	WaveInth	delta	A	nf	ni	A	eV		
 	A 1215.7			2	1	911.74	13.6	<u> </u>	
<u> </u>			 	2	1	-911.74	-13.0	3 ·	·_
<u> </u>	911.8 911.8		911.74		2	911.74	13.0	3	
<u> </u>				1	1	-227.93	-54.4	4	
-	584.5		373.60		1	373.60	33.	2 CS-He	
<u></u>	373.7 303.784				3	303.9			
-	280.2				1	280.5	4 44.	2cs-H	
-	280.8				1	280.5	<u> </u>	2 CS-H	<u> </u>
-	264.8				4	265.0	•	8 CS-He	<u> </u>
-	228				1	227.9			<u> </u>
-	215.16				4	214.5	57 .	8cs-H	<u> </u>
—	182.16				4	182.3		0	
-	167.5				5	167.5	9 74.	0 CS-He	
-	152.15				1	82.8	9 149.		
-	145.9				5	145.8		Ocs-H	
-	145.5				2	141.5		.6 C S - He	
-	129.8				5	130.2		.2	
\vdash	125.5				2	125.7		.6 CS-H	
-					6	122.5		2 CS-He	
-	122.				2	113.9		.8	
	114				6	110.5		.2 cs-H	1
	110.					101.3			-1
ļ									
	101. 96.				7	96.5		.4 C S - He	+





Mills Prediction vs. Data

		_							
	88.8	-0.17%	88.95	8	7	88.95		CS-H	
	87	-0.38%	87.33	5	3	87.33	142.0		
	82.9	0.02%	82.89	8	7	82.89	149.6		
 	81.1	0.07%	81.04	5	3	81.04	153.0	H	
	79.58	-0.14%	79.69	9	8	79.69	155.6	He	
 	76	0.03%	75.98	5	3	75.98	163.2		-
	70.1	-0.05%	70.13	9	8	70.13	176.8		
<u> </u>	67.5	-0.50%	67.84	10	9	67.84	182.8	He	
	63.12	-0.03%	63.14	6	4	63.14	196.4	He	
<u> </u>		0.36%	60.78		9	60.78	204.0		
	61	-0.14%	59.79	6	4	59.79	207.4		
	59.7	-0.14%	39.19						
			<u> </u>						1
<u> </u>	 	20 - 5-	- Francisco I	N/ Speetm	I Data ***				
<u> </u>			Extreme L		I Data	 			
	OBSERVE		MILLS PR	EDICIED					+
	SF Au Mic	EQ Pegasi	Manalat						
<u></u>			WaveInth			A	eV		
<u></u>	A	Α	A	nf	ni .		<u> </u>		
				<u> </u>	3	303.91	40.8		+
<u> </u>		304				265.01			+
<u> </u>		265			4	182.35	68.0	ne	
	183				4	167.59	74.0	U ₀	-
<u></u>	168		167.6		5	130.25	95.2		+
	130				5	125.76	98.6		-
	126		125.8		2	123.76	101.2		-
	123				6	113.97	108.8		1
ļ	114		114.0		6	110.51	112.2		-
ļ	111		110.5		6	101.30	122.4	n	+
<u> </u>	101				7	96.58	128.4	Lia .	
	97		96.6		7	88.95	139.4		-
	90				3	87.33	142.0		
<u> </u>	87		87.3		7	82.89	149.6		1
	83				3	81.04	153.0		
	81		1			79.69	155.6		
<u> </u>	79.5		79.7		8 3	75.98	163.2		
	76	ļ	76.0	5	3	75.90	103.2		
	<u> </u>	<u> </u>	ļ					 	
	↓		 		ļ				-
	<u> </u>		<u> </u>	10	<u></u>			 	
	- Raw Ex	ctreme UV	Backgroun	u spectral	uata of the order	ultroviolot backs	round	 	+
<u> </u>					or me exceme	ultraviolet backg	, UID	 	
 			371, (1991), pp ' Solar Spe			 		 	+
-	- Kaw E	Domas P 1 A	Journal W.M.	Astronhysical	Journal Supple	ment Series, Vo	L 91, (1994) i	D. 461-482	
	Malinowsky A	Hemir I	Astrophysical .1	ournal Vol. 18	1. (1973). pp. 1	009-1030 - Fig	res 1a-d	1	
 	Noves R Th	re Sun. Our St	ar, Harvard Uni	versity Press	Cambridge. MA	, (1982), p. 172	- Figure 7.5		1
—	Phillips. J.H.	Guide to the S	un, Cambridge	University Pres	ss, Cambridge,	Great Britain, (1992), pp. 118	-119 ,	
	120-121, 144		1		I				
	*** - Other	Raw Extr	eme UV Sp						
			ience, Vol. 263,	, (1994), pp. 55	-59; Fossi, B.C	.M.,et.al., Astro	physical Journ	nal, Vol. 449,	
	(1995), pp. 3	76-385		1		<u> </u>	L		





THESIS - APPENDIX FOUR

entered provinced deposits of

estimate physical property









Notebook No. PROJECT Atlantic Energy lest Continued From Page 5/196@700pm coated onto sides to 6 250 C on temp 050196 read high 5 2 96 @ 10:00 am gache disable 050296 8300 1 5/3/96@9:30av on Why = (100.9 dell w/Hz to @ ATM @ 9.45 am - closed valve to vacuum, vacsurierd Continued on Page value to vac viten





PROJECT ALAUGE	ENERGYTEST	Notebook No
5/3/96@9:48a		
@ 10-45		42/717/27 18/eZ.17
Temp Contr	oler Time on = 22	15 28 28 78, 78 28, 74
1261	22.12 - 97.0 2P.74	WET = 78.42
@10:10 av	- turned on Silo	ment to @ 15 W.
J2 V= Z6.	06 7 - 0.289	
CPW 15 am	-first tive cart. h easing filament vo	trocieles totale on since
@11:45 am		Avg
Jeng Con	troler Tive or	20.94/21.00/21.12/21.02
(N:n=1	27.2 × 8.07 481	475 Per 28.08
97.05-	4547-15111 1511 on - STIW	(33,47 W) S
(c. 150)	in creased filaren	Hattage to @ 25 W.
7= 361	15 15 0.35 x	< Z , W = Z 5, 31
@12:05 pm -	first sine vit che	ches on since increasing
	•	and Understood By
Str Bd	5/3/96 h,	M 73/96



ATLANTIL ENERGY TEST 5/3/90@12-15p Continued on Page

ACT COLOR





6: Notebook No F. TEST Continued From Page ATLANTIL PROJECT_ 00401 8:33pm VIDEO is mon Pour Continued on Page Read and Understood By Star Belian





Withersol: Mad Custe. 10:45 th 5/3/96

Auto mess 2:50 pm 5/3/96

Star Bolling 2:50 pm 5/3/96

Ma policina

SON WAS ELVER

venosited w





5/3/96 LEST RUN BECAM 10:45 AM 2:50 PW PLOTO MEDI •

3:04 may 3

100000

Salar Maria 是是

Series of the series

angio molecular

nedendari medendari

the course









The following is a list of the column headings and their meanings for the PEC data spreadsheet:

Column 1, Time(sec)-the time in seconds for each data point from the initial time (To) when the data acquisition system was started

Column 2, Room Temperature-room temperature measured on the data acquisition board

Column 3, Temperature(°C)-cell temperature in °C measured from the type K thermocouple which is positioned in a thermocouple well in the top flange of the vessel

Column 4, Watts-wattage going into either the cartridge heater or filament (depending on which it is connected to) at each of the data points

Column 5, Hours Elapsed-the time in hours elapsed from the initial time (To) when the data acquisition system was started; this number is calculated by dividing the corresponding seconds in column 1 by 3600 in order to convert from seconds to hours.

Ex. $50 \sec(x) 1 \min/60 \sec(x) 1 hr/60 \min = 50/3600 (hr) = 0.014 hours$

Dorta - Excel Graphics : Pic





!PEC0503

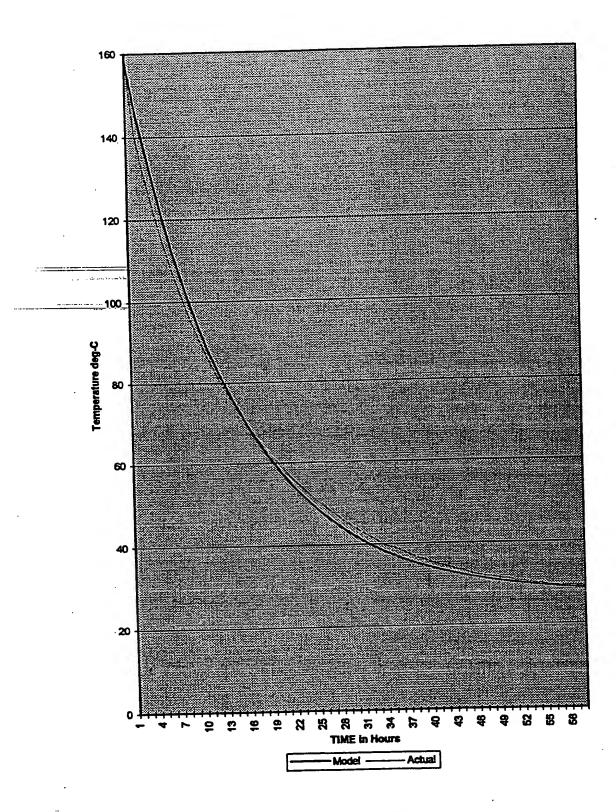
36887	27.082	268.98	42.563	10.24639	
36907	27.082	269.07	42.635	10.25194	
36927	27.082	268.99	42.655	10.2575	
36948	27.081	268.88	42.544	10.26333	
36968	27.08	268.9	42.546	10.26889	
36988	27.081	268.92	42.614	10.27444	
37008	27.083	268.87	42.626	10.28	
37028	27.08	268.9	42.551	10.28556	
37048	27.082	268.86	42.634	10.29111	
37068	27.083	268.91	42.552	10.29667	
37088	27.081	268.85	42.641	10.30222	
37108	27.082	268.91	42.635	10.30778	
37128	27.082	268.93	42.561	10.31333	
37148	27.08	268.78	42.543	10.31889	
37168	27.08	268.81	42.527	10.32444	
37188	27.079	268.93	42.528	10.33	
37208	27.079	268.78	42.565	10.33556	
37228	27.077	268.82	42.609	10.34111	
37248	27.078	268.72	42.651	10.34667	
37268	27.079	268.91	42.596	10.35222	
37288	27.078	268.84	42.542	10.35778	
37308	27.076	268.6	42.524	10.36333	
37328	27.077	268.74	42.568	10.36889	
37349	27.078	268.82	42.642	10.37472	
37369	27.077	268.73	42,58	10.38028	
37389	27.078	268.84	42.523	10.38583	
37409	27.077	268.77	42.593	10.39139	
37429	27.08	268.76	42.61	10.39694	
37449	27.078	268.71	42.51	10.4025	
37469	27.076	268.64	42.537	10.40806	
37489	27.076	268.73	42.619	10.41361	
37509	27.078	268.7	42.565		
37529	27.079	268.69	42.507	10.42472	
37549	27.078	268.66	42.54	10.43028	
37569	27.078	268.59	42.62		
37589	27.077	268.59	42.532		
37609	27.078	268.63			
37629	27.078	268.67	42.624		
37649	27.078	268.51	42.53		
37669	27.079	268.59	42.493		
37689	27.079	268.47	42.503		
37709	27.078	268.56	42.528		
37729	27.08	268.51	42.577		
37750	27.077	268.41	42.613		
37770	27.079	268.52	42.493		
37790	27.077	268.46			
37810	27.078	268.5			
37830	27.078	268.46			
37850	27.077	268.43			
37870	27.076	268.36			
37890	27.076	268.48			
37090	21.010	200.40	72.770	10.020	<u> </u>





Heat Loss Model - Vers 1.1 Chart 2

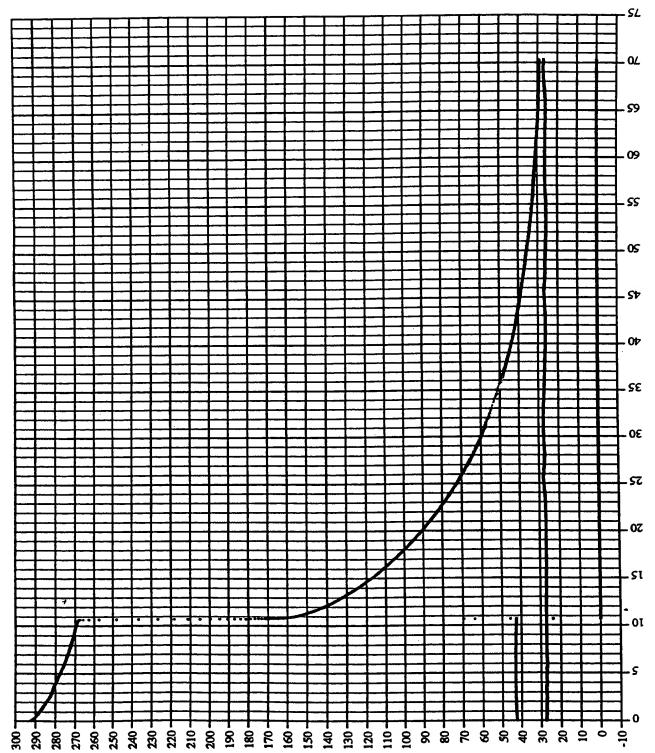
Model vs. Actual Data



Page 1

PEC 050396 310p H fil ex*

Desaro!



Room Temp Temp(°C) Watts



Hrs Elapsed









4.1...

.

....

........

babalo spilo

OVERVIOUS.

THESIS - APPENDIX FIVE

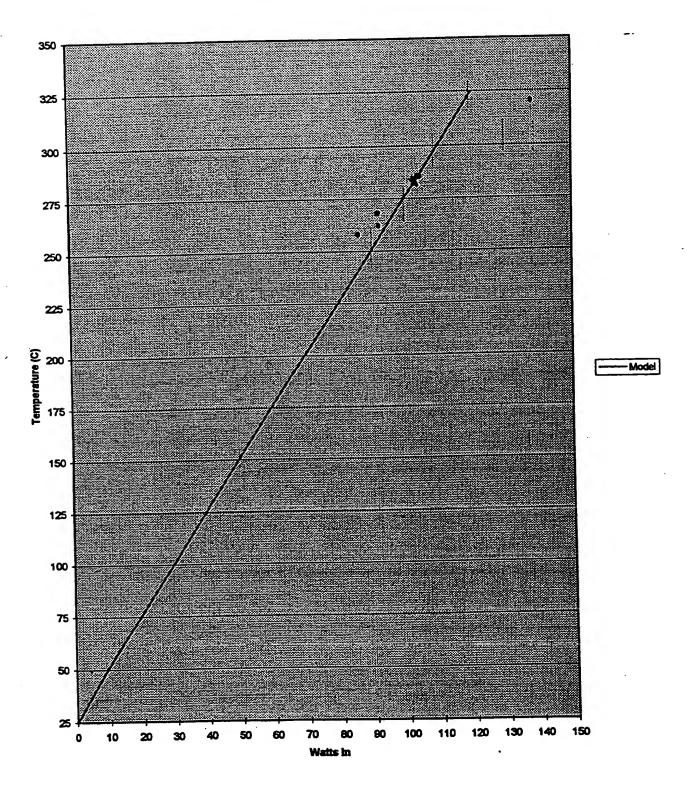






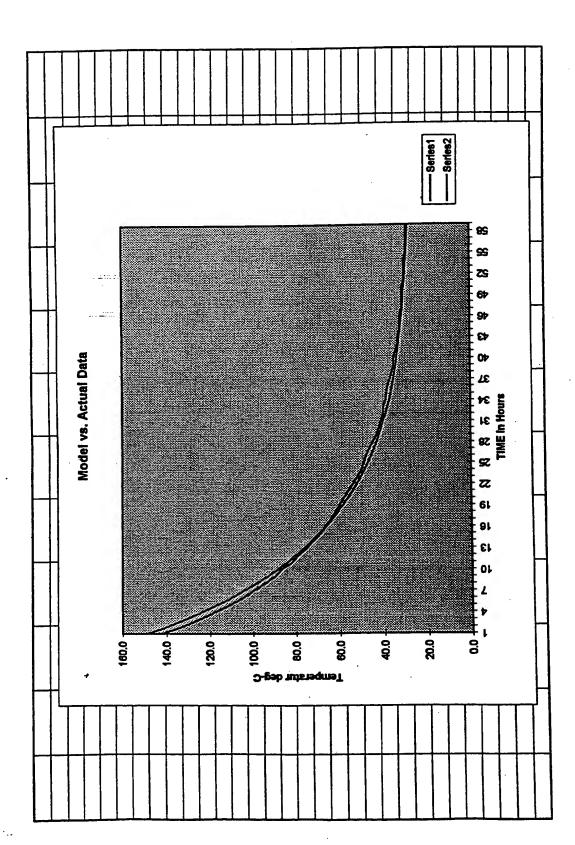


Isothermal Cell - Heat Loss



Page 1



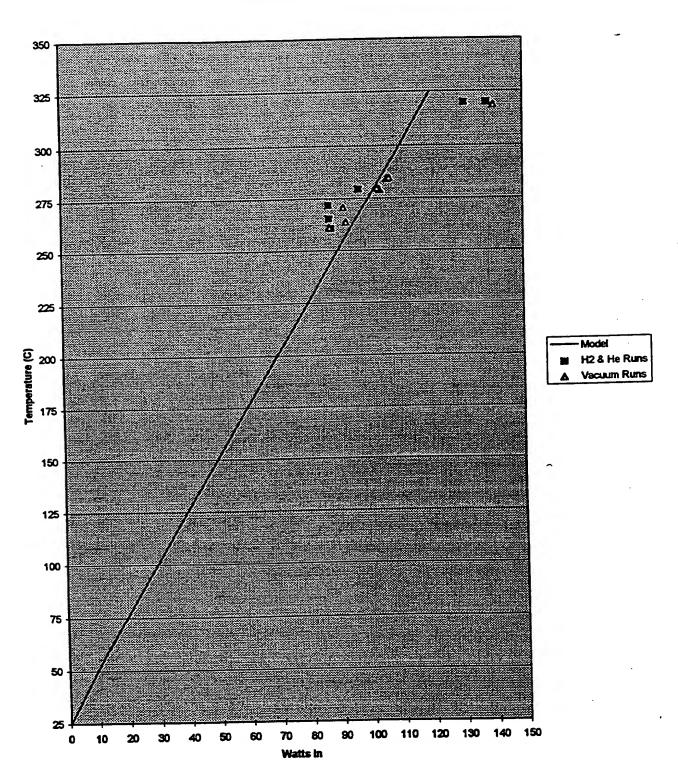


Page 6





Isothermal Cell - Heat Loss







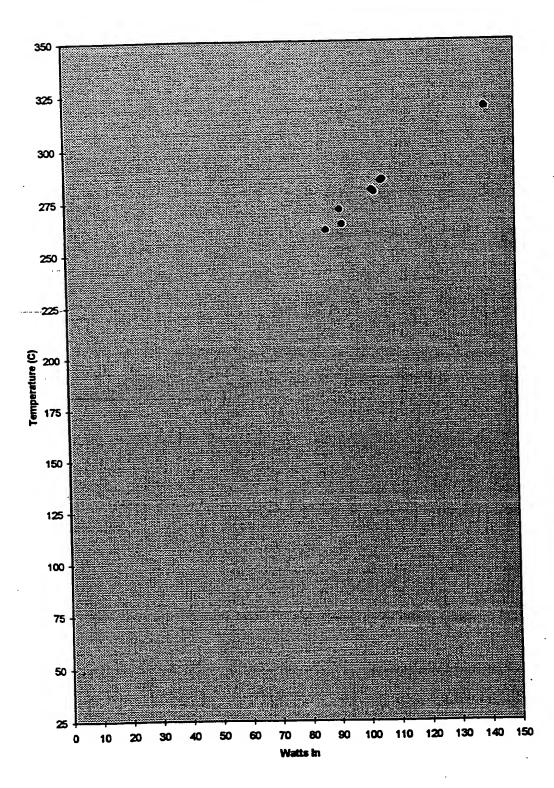
BLP Isothermal Cell Model

	ALL RUNS WITH ISOT	HERMAL CALORIN	IE I EK	
xperimental Run	Cell Pressure (mtorr)	Temperature (C)	Steady State Watts	
Aperimental Nen			Cartridge Heater Only	Gas
15.6	38	270.73	91.95	٧
15.0	1800	271.79	87.07	H2
15.8	48	261.07	87.29	V
10.0	1350	260.82	87.85	H2
15.9	109	279.49	103.48	V
10.0	1150	279.5	97.05	H2
15.10	56	263.72	92.71	V
10.10	1600	265.41	87.16	H2
15.12	21	284.33	106.02	V
19.12	20	284.72	106.71	V
15.13	2000	319.91	138.29	He
13.13	35.5	318.45	140.45	V
	1900	319.83	131.22	H2
16.2	22.3	279.01	103.7	V
10.2	22	279.97	102.96	V
Cell Pressure (mtorr)	VACUUM RUNS ONL'	Steady State Watts		
Cell Pressure (mtorr)	Temperature (C)		<u> </u>	↓
		Cartridge Heater Only		╂—
38	270.73	91.95	V	+-
48	261.07	87.29	V	┪—
-109	279.49	103.48	V	╂┈
56	263.72	92.71	V	+-
21	284.33	106.02	V	╫
20	284.72	106.71	V	+-
35.5	318.45	140.45	V	+
22.3	279.01	103.7	V	+
22	279.97	102.96	V	
				-
	GAS RUNS ONLY WI	TH ISOTHERMAL C	ALORIMIER	+
Cell Pressure (mtorr)	Temperature (C)	Steady State Watt	\$	
		Cartridge Heater Only		
4000	271.79	87.07	H2	+
1800	260.82	87.85	H2	1
1350		97.05	H2	- -
1150	279.5	87.16	H2	\dashv
1600	265.41	07.10	I I I I I I I I I I I I I I I I I I I	
2000	319.91	138.29	He	





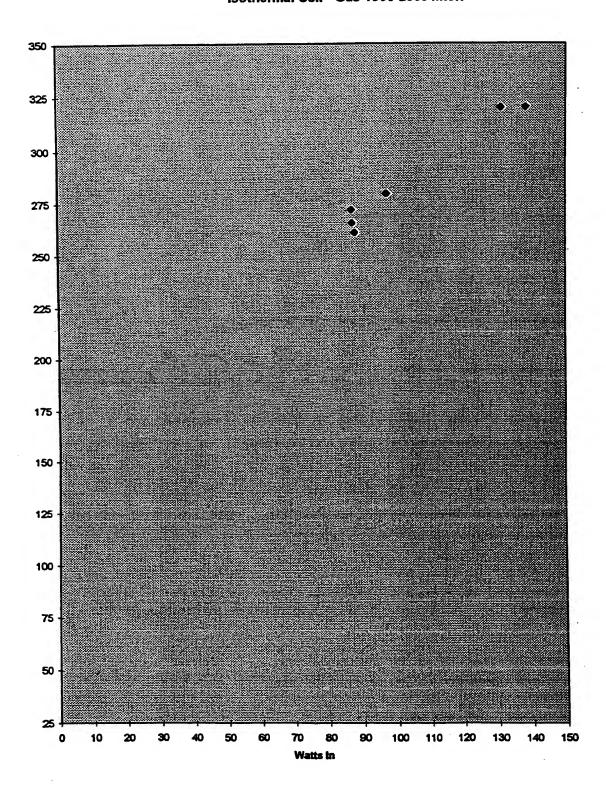
Isothermal Cell - Vacuum







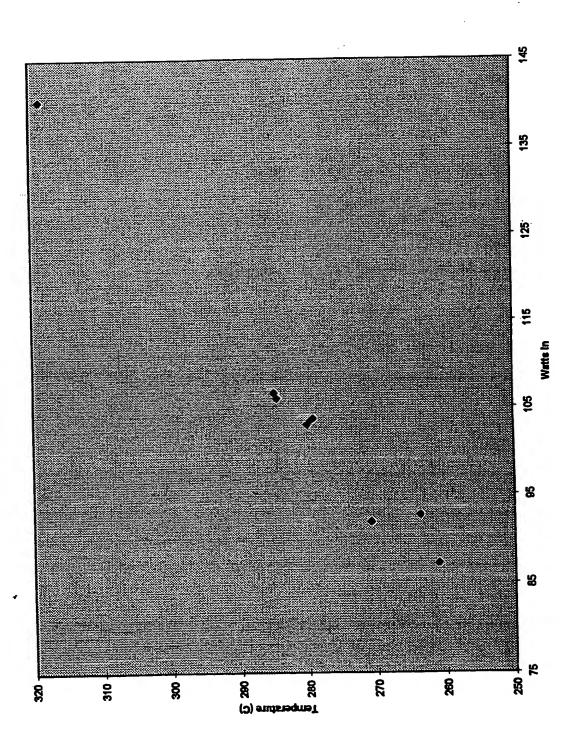
Isothermal Cell - Gas 1500-2000 mtorr







Isothermal Cell - Vacuum







Dear Peter,

Here is the data for the isothermal calorimeter which you requested. I tried to give you the most complete and representative data for our work on the isothermal calorimeter. The data includes one control and one experiment for a short (66 cm) tungsten filament, and also one control and five experiments for a longer (200 cm) tungsten filament. Varying diameters of tungsten filament were used for the 200 cm experiments and these diameters are noted. Other variables and data are listed under each experiment number (15.x) and description.

If you have any questions about the data, give me a call.

Sincerely,

Stev Bollinger





BLP & Maior US University BLP & Maior US University BLP & Maior US University BES3 2000 1850 1853 2000 1853 2000 1853 2000 1853 2000 1800 1800 1800 1800 1853 2000			_							+	+		T
BLP & Malor US University Power Inputs & Outputs [watter Volume Pressure Temperature CHW FW TOTW EHW CHW TOTW EHW CHW FW TOTW CHW FW TOTW CHW FW TOTW EHW CHW TOTW CHW FW TOTW CHW FW TOTW	Analy	Analy	Analy	Analy	sis of Black	Light Pow	er Gas Phas	e Cells	1	+		-	
Gas Cell Characteristics						BLP & Mai	or US Univer	Sity		+	†	-	
Second Communication Commu													
Second State Temperature CHW EW TOTW EHW EHW EHW TOTW EHW EHW						0 0	haracterietic	9	Power Ir	puts &	Output	watt	
1853 2000 38 270.73 91.95 0 91.95	t Characteristi	t Characteristi	aracteristics [cm-cm2	cs cm-cm2		Sas cell o	Descrire	mperature	CHW				Š
2000 38 270.73 91.95 0 91.95 2000 48 270.73 91.95 0 91.95 2000 48 271.79 87.07 0 87.07 2000 48 281.07 87.29 0 87.26 2000 1350 260.82 87.85 0 87.85 100 1350 279.49 12.06 50.4 62.46 2000 109 279.49 103.48 0 103.48 1150 279.49 103.48 0 103.48 1150 279.49 103.48 0 103.48 1150 279.49 103.48 0 103.05 1150 279.49 103.48 0 103.05 2000 56 269.34 57.3 35.94 41.67 1600 289.27 1.82 30.36 32.16 2000 200 275.7 1.82 30.36 32.18 <	Diameter	Diameter	Diameter	Surace A	E	Volulie	Т		1		0		
2000 38 270.73 91.95 0 91.95 2000 1800 271.79 87.07 0 87.07 2000 48 279.27 0 43.58 433.58 433.58 2000 48 281.07 87.29 0 87.29 2000 1350 289.38 12.06 50.4 62.46 2000 109 279.49 103.48 0 87.29 1150 279.49 103.48 0 103.48 1150 279.5 87.05 0 87.16 2000 56 269.24 5.73 35.94 41.67 2000 56 263.72 92.71 92.71 1600 275.7 1.82 30.36 32.18 1600 275.7 1.82 30.36 32.18 2000 20 284.33 108.02 0 108.71 2000 2000 286.49 62.15 35.09 97.81	2	2									0		
2000 38 270.73 91.95 0 91.95 2000 1350 271.79 87.07 0 87.07 2000 279.27 0 43.58 443.58 743.58 2000 48 281.07 87.29 0 87.29 2000 100 280.82 87.85 0 87.85 1150 279.49 10.348 0 87.85 1150 279.5 87.05 0 87.85 11600 279.5 97.05 0 97.05 2000 58 265.41 87.16 87.16 1600 285.41 87.16 87.16 87.16 2000 20 275.7 1.82 30.36 32.18 2000 21 284.33 106.02 0 108.71 2000 20 286.43 54.96 42.85 97.81 2000 20 286.72 60.71 47.19 107.9 <t< td=""><td></td><td>66.04</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>0</td><td></td><td></td></t<>		66.04									0		
2000 38 270.73 91.95 0 91.95 2000 1350 271.79 87.07 0 87.07 2000 48 281.07 0 87.29 2000 48 281.07 87.29 0 87.85 2000 109 280.82 87.85 0 87.85 100 109 279.49 103.48 0 103.48 1150 279.49 103.48 0 97.05 1150 289.24 5.73 35.94 41.67 2000 58 283.72 92.71 92.71 1600 285.71 87.16 87.16 2000 210 284.33 106.02 0 2000 20 284.33 106.02 0 2000 20 284.72 106.71 0 2000 20 284.72 60.16.71 0 2000 20 326.24 64.86 97.61	2	86.04	2										
1800 271.79 87.07 0 87.07 2000 48 281.07 0 43.58 43.58 43.58 43.58 43.58 43.58 43.58 43.58 43.58 43.58 43.58 43.58 87.29 0 87.29 0 87.29 0 87.85 0 87.85 0 87.85 0 87.85 0 87.85 0 87.85 0 87.85 0 87.85 0 87.85 0 87.85 0 87.86 0 87.86 0 87.86 0 87.86 0 87.86 0 87.86 0 97.05 0 97.05 0 97.05 0 97.05 0 97.05 0 97.05 0 97.05 0 97.05 0 97.05 0 97.05 0 97.05 0 97.05 0 97.05 0 97.05 0 97.05 0 97.05 0 97.05 0 97.05 <	200 0.01	200 0.01	0.01		23.1833			270.73	91.95	0	91.95	па	
2000 48 279.27 0 43.58 43.68 43.58 43.68<	KNOZ						1800	271.79	<u> </u>	0	87.07	ПВ	
2000 48 281.07 87.29 0 87.29 2000 48 281.07 87.85 0 87.85 2000 109 att 2260.82 87.85 0 87.85 2000 109 att 279.49 103.48 0 103.48 1150 279.5 97.05 0 97.05 2000 56 289.24 5.73 35.94 41.67 2000 56 283.72 92.71 92.71 1600 285.41 87.16 87.16 1600 275.7 1.82 30.36 32.18 2000 275.7 1.82 30.36 32.18 160 284.72 106.02 0 106.02 2000 284.72 106.71 47.19 107.9 2000 2000 326.24 60.71 47.19 107.9	7527	2					1350	279.27	0	43.58	43.58	73.49 V	
2000 48 281.07 87.29 0 87.29 1350 260.82 87.85 0 87.85 2000 109 stm 289.38 12.06 50.4 62.46 2000 109 stm 279.49 103.48 0 103.48 2000 56 279.5 97.05 0 97.05 2000 56 263.72 92.71 87.16 87.16 2000 56 265.41 87.16 87.16 0 2000 21 284.33 106.02 0 106.02 2000 21 284.33 106.02 0 106.71 2000 20.8 288.54 62.15 35.09 97.241 2000 20.0 284.72 106.71 0 106.71 2000 2000 326.24 60.71 47.19 107.9	004	200	004		131853							1	
48 281.07 87.29 0 87.29 1350 260.82 87.85 0 87.85 2000 109 279.49 12.06 50.4 62.46 2.46 2000 109 279.49 103.48 0 103.48 1700 289.24 5.73 35.94 41.67 2000 56 263.72 92.71 92.71 1600 265.41 87.16 87.16 92.71 2000 21 265.41 87.16 92.71 2000 21 264.33 106.02 0 106.02 2000 21 284.33 106.02 0 106.71 2000 20.8 288.54 54.96 42.85 97.81 2000 2000 328.24 60.71 47.19 107.9	200 001	200 001	0.01		31853				- 1				
1350 260.82 87.85 0 87.85 2000 109 279.49 12.06 50.4 62.46 2.46 2000 109 279.5 97.05 0 97.05 2000 56 263.72 92.71 92.71 2000 26 265.41 87.16 87.16 2000 21 284.33 106.02 0 2000 21 284.33 106.02 0 2000 20.8 284.72 106.71 0 2000 20.8 284.72 106.71 0 2000 284.33 106.02 0 106.02 2000 20.8 284.72 106.71 0 106.71 2000 2000 318.91 138.29 0 138.29 2000 2000 326.24 60.71 47.19 107.9							48			0	87.29	E	
2000 109 279.49 103.48 0 103.48 2000 109 279.5 97.05 0 97.05 2000 58 263.72 92.71 92.71 2000 286.41 87.16 87.16 2000 275.7 1.82 30.36 32.18 2000 21 284.33 106.02 0 106.02 2000 21 284.33 106.02 0 106.71 2000 20.8 284.33 106.02 0 106.71 2000 20.8 284.72 106.71 0 106.71 2000 2000 318.91 138.29 97.81 2000 2000 326.24 60.71 47.19 107.9	VAC						1350			0	87.85	L L	
2000 109 279.49 103.48 0 103.48 1150 279.5 97.05 0 97.05 2000 58 289.24 5.73 35.94 '41.67 2000 58 263.72 92.71 92.71 1600 265.41 87.16 87.16 2000 275.7 1.82 30.36 32.18 2000 21 284.33 106.02 0 106.02 200 20 284.72 106.71 0 106.71 200 20.8 288.54 62.15 35.09 97.241 200 20.8 284.72 106.71 0 106.71 2000 20.0 318.91 42.85 97.81 2000 2000 326.24 60.71 47.19 107.9	7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7						low atm		\perp	50.4	62.48	25.39	
109 279.49 103.48 0 103.48 1150 279.5 97.05 0 97.05 2000 56 289.24 5.73 35.94 41.67 2000 56 263.72 92.71 92.71 2000 265.41 87.16 87.16 2000 275.7 1.82 30.36 32.18 2000 21 284.33 106.02 0 106.02 200 20.8 284.33 106.02 0 106.71 200 20.8 288.54 62.15 35.09 97.241 200 20.0 318.91 138.29 0 138.29 2000 2000 328.24 60.71 47.19 107.9	200 0.01	200 0.01	0.01		31853					Í			
279.5 97.05 0 97.05 1700 289.24 5.73 35.94 41.67 2000 58 263.72 92.71 92.71 1600 285.41 87.16 87.16 2000 275.7 1.82 30.36 32.18 2000 21 284.33 106.02 0 106.02 200 20.8 288.49 62.15 35.09 97.241 200 20.6 288.54 54.96 42.85 97.81 2000 2000 318.91 138.29 0 138.29 2000 328.24 60.71 47.19 107.9							109		~ ∤	ō	103.48		
2000 56 263.72 92.71 92.71 2000 56 265.41 87.16 87.16 2000 275.7 1.82 30.36 32.18 2000 21 284.33 106.02 0 200 21 284.33 106.02 0 106.02 20 20 284.72 106.71 0 106.71 2000 20.8 288.54 54.96 42.85 97.81 2000 2000 318.91 138.29 0 138.29 2000 326.24 60.71 47.19 107.9	Khuz						1150		9	0	97.05		
2000 58 263.72 92.71 92.71 1600 265.41 87.16 87.16 87.16 2000 275.7 1.82 30.36 32.18 2000 21 2284.33 106.02 0 106.02 20 20 284.72 106.71 0 106.71 20 20 284.72 106.71 0 106.71 2000 20 288.54 62.15 35.09 97.241 2000 20 284.72 106.71 0 106.71 2000 318.91 138.29 0 138.29 2000 326.24 60.71 47.19 107.9	2002									35.94	41.67	22.32	
56 263.12 92.71 92.71 1600 265.41 87.16 87.16 2000 275.7 1.82 30.36 32.18 2000 21 284.33 106.02 0 0 2000 21 284.33 106.02 0 106.02 20 20 284.72 106.71 0 106.71 2000 20.8 288.54 62.15 35.09 97.241 2000 20.0 318.91 138.29 0 138.29 2000 328.24 60.71 47.19 107.9	200 0.01	200 0.01	0.01		33185.				- 1		77.00	6	
2000 275.7 1.82 30.36 32.18 2000 21 284.33 106.02 0 106.02 20 21 284.33 106.02 0 106.02 20 284.33 106.02 0 106.02 20 284.72 106.71 0 106.71 2000 20.8 288.54 54.96 42.85 97.81 2000 2000 318.91 138.29 0 138.29 2000 326.24 60.71 47.19 107.9							26		1.		87.18		
2000 21 284,33 108,02 0 108,02 2000 21 288,49 62,15 35.09 97,241 20 284,72 108,71 0 108,71 2000 20,8 288,54 54,96 42,85 97,81 2000 2000 318,91 138,29 0 138,29 2000 328,24 60,71 47,19 107,9	202			-			1800		<u>'</u>			1	
2000 21 284.33 106.02 0 108.02 19 288.49 62.15 35.09 97.241 20 284.72 106.71 0 108.71 2000 288.54 54.98 42.85 97.81 2000 2000 318.91 138.29 0 138.29 2000 328.24 60.71 47.19 107.9	2000	2000	0.025		79832		-				0		
21 284,33 106.02 0 108.02 19 288,49 62.15 35.09 97.241 20 284,72 106,71 0 106,71 2000 2000 318.94 42.85 97.81 2000 318.91 138.29 0 138.29 2000 326.24 60.71 47.19 107.9	200 0 002	200 0 002	0.025		79832		0				0		
19 288.49 62.15 35.09 97.241 20 284.72 106.71 0 106.71 20.8 288.54 54.96 42.85 97.81 2000 2000 318.91 138.29 0 138.29 2000 328.24 60.71 47.19 107.9	2007						2				108.02		
20 284.72 106.71 0 106.71 20.8 288.54 54.98 42.85 97.81 2000 2000 318.91 138.29 0 138.29 2000 328.24 60.71 47.19 107.9	Na.						100			Ш		8	
20.8 288.54 54.98 42.85 97.81 2000 2000 318.91 138.29 0 138.29 2000 328.24 60.71 47.19 107.9	754	7					20				•		
2000 318.91 138.29 0 138.29 2000 328.24 60.71 47.19 107.9	٨٧٤	-		1			20.6						
2000 318.91 138.29 0 138.29 2000 328.24 60.71 47.19 107.9	Canton 200 0.025 15.70	200 0.025	0.025		79832			i la	-		_		
2000 328.24 60.71 47.19 107.9							2000		_		┖	-	
							200			_1			
	200 0.025	200 0.025	0.025		079832		0						





 ئے ا	· X	 [-	<u>.</u>	<u>₹</u>	\neg	1	7		1	1			Τ	T	T	_		
na	11.22	3	E	44.95	47.63			21.08	na										_
0 140.45	48 R4 129.23	207	131.22	88.27 44.95	74.8 83.588 47.63		103.7	82.636	0 102.96	٥	0	0							
0	48 84	2	0	47.77	1 1		0	39.99	0										
140.45	82 50	3	131.22	38.5	8.79		103.7	42.85	102.98										
318,45 140.45	222 28 82 50	323.00	319.83 131.22	328.48	331.03		279.01	281.82	279.97										
35.5	2 6	27	1900	1600	1900		22.3	19	22										_
																_		-	
						2000				20	20	200	2						
						15.70798325				1.570796325	1 570798325	4 ETOTOB99E	1.07/1/180920						
-						0.025		-	+	0.025	0.025	2000	0.025					+	
						200			-	20	200	3 8	27						
	VBC	Vac	5	725	22	Control	207	200	200	H2 Biin		וומע דע	HZ Run						
			-		+	PI D.18 2	1	+	+	MICIL4	C 100 11	Z-000M	MUSU-3		-	+	+		 -





Confidential	Isothermal Calorimeter Data	Calorimeter	Data	_		- 1			
					15.9-KN02, 200 cm(0.01		m dia) tung	cm dia) tungsten filament	1
			en filoment		status		Weart htr	Wfil	Wtotal
NOZ, 66	m(0.41 cm	cm(U.Q. cm dia) tungsteri ina		Wrotal	109 torr	279.49	103.48	0	103.48
	Temp("C)	Weart ntr will	(W.Cotal	H2 1 15 torr	279.5	97.05	0	97.05
vac 0.075 torr	258.7	95.2	ס	33.6		7000		25 94	41.67
H2 1.6 torr	255.45	65.4	6.95	72.35	HZ 1.7 tor	77.607		10:00	
H2 2.0 torr	256.91	55.03	8.16	63.19					
H2 2 0 torr	257.87	43.62	10.36	53.98					
12 . 2 0 torr	259 05		16.96	45.72	15.10-KNO2, 20(200 cm(0.01	cm dia) tur	in filan	ent
101 0.2< 20	F33:03				status	Temp(°C)	Wcart htr	Wfil	Wtotal
					vac 0.056 torr	263.72		0	92.71
- 1				ingsten filament	H2 1.6 torr	265.41	87.16	0	87.16
15.5-(control), el	mpty oo ci	empty of ciri(0.01 ciri dia)		14/401	H2 1.6 torr	275.7	1.82	30.36	32.18
status	() () ()	Š Š		04.22					
vac 0.086 torr	272.88	94.33							
H2 > 2.0 torr	272.55	83.31	5.05	88.36					
H2 ~2 0 torr	273.68	81.12	8.23	89.35	15.12-KN02, 20	0 cm(0.02	5 cm dia) t	ten riia	ment
12 2 0 42	272 67	L	٦		status	Temp(°C)	Š		Wtotal
HZ 2.0 torr	275 64				vac 0.021 torr	284.33	106.02	0	106.02
HZ IOW A I M	27.07				vac 0.019 torr	288.49	62.15	35.091	97.24
					vac 0.020 torr	284.72	106.71	0	106.71
			•	100	vac 0.0208 torr	288.54	54.96	42.85	97.81
15.6-KNO2, 200 cm(0.01		cm dia) tungsten	Sten mamen	ובוור					
status	Temp(°C)	Weart htr	Wfil	Wtotal					
vac 0.038 torr	270.73	91.95	0						
U2 1 8 torr	271.79		0	87.07	15.13-KN02, 20	00 cm(0.05	S cm dia)	200 cm(0.025 cm dia) tungsten mament	meur
112 1.0 Coll	279 27		43.58	43.58	status	리	ĕ∐		Wtotal
1.33 (0)					vac 0.0355 torr	318.45	5 140.45		140.45
					vac 0.020 torr	323.36	82.59	46.638	129.23
			س ا	tingeton filament	H2 1.9 torr	319.83	3 131.22	0	131.22
15.8-(control), empty 200 cm(0.01 cm dia	ampty 200	Cm(0.01 C	_ i	Wenter of Marie	H2 1.6 torr	328.48	8 38.5	5 47.77	86.27
status	lemp(C)	<u>اڭ</u>		87.29	H2 1.9 torr	331.03	3 8.79	9 74.798	83.59
vac 0.048 torr	261.07				He 2.0 torr	318.91	1 138.29	0	138.29
H2 1.35 torr	260.82				100 O C CL	326 24	4 60.71	1 47.194	107.90
77-4	20020	1200	A CS	1 62.46	Te 7.0 for	3.03.0			









THESIS - APPENDIX SIX









Final report for period October-December 1996 In fulfillment of Service Contract with HydroCatalysis Power Corp. (now BlackLight Power, Inc.)

REPORT ON CALORIMETRIC INVESTIGATIONS OF GAS-PHASE CATALYZED HYDRINO FORMATION

Submitted by Prof. Jonathan Phillips* and Julian Smith Department of Chemical Engineering Penn State University University Park, PA 16802

Ph: (814) 863-4809 Fax: (814) 865-7846 Ph: (814) 863-8407 Fax: (814) 863-8561

Professor Stewart Kurtz

Penn State University University Park, PA 16802

Department of Electrical Engineering

Irlian Smith

Stewart Kurtz









SUMMARY

Tests for heat production associated with hydrino formation were carried out with two types of calorimeters during the period October-December 1996. Experiments carried out in a modified Calvet system yielded extremely exciting results. Specifically, initial results are apparently completely consistent with the Mill's Hydrino formation hypothesis. In three separate trials between 10 and 20 K Joules were generated at a rate of 0.5 Watts, upon the admission of approximately 10-3 moles of hydrogen to the 20 cm³ Calvet cell containing a heated platinum filament and KNO3 powder. This is equivalent to the generation of 1*10⁷ J/mole of hydrogen, as compared to 2.5 *10⁵ J/mole of hydrogen anticipated from standard hydrogen combustion. Thus, the total heats generated appear to be two orders of magnitude too large to be explained by conventional chemistry, but the results are completely consistent with the Mill's model. It must be noted that although the results presented in this report are very exciting, they require further verification. Moreover, it should be noted that some control studies are not yet complete.

Also included is a brief report on an attempt to replicate the Calvet cell results on a larger scale using the water bath calorimeter (described in some detail in an earlier report). Unfortunately, no evidence of 'excess heat production' was found. This can be linked to a failure to maintain the catalyst ions (K+) in the vapor phase. Specifically, it is hypothesized that the KNO3 catalyst evaporated from the containing pot at the reactor center, where the temperature is high, and deposited on the reactor walls, which are cold due to immediate contact with the calorimeter water bath. (That is, the catalytic material is 'cryo-pumped' by the cold walls.) Indeed, at the conclusion of the experiment, when the reactor was removed from the water bath, the walls of the quartz reactor were observed to be white in the general vicinity of the pot which contained the KNO3.





INTRODUCTION

Experiments were conducted to test the hypothesis that in the gas phase potassium ions will catalyze the conversion of hydrogen atoms to hydrino atoms. These experiments were initially carried out in a Calvet cell as this type of calorimeter is highly sensitive and accurate. Moreover, the conditions of the calorimeter are controlled.

RM's theory of hydrino formation requires that both K+ ions and H-atoms are present in the gas phase. In order to generate gaseous K+ ions, KNO3 is placed in a small (2cc) quartz 'boat' inside the calorimeter cell. The boat is heated, to increase the vapor concentration of KNO3, with a platinum filament, which is wound around the boat. A second function of the platinum filament is to generate H-atoms. It is well known that hydrogen molecules in contact with a heated filament will decompose, yielding a relatively high H-atom concentration in the boundary layer around the filament. Thus, according to RM's model, in a cell containing KNO3 in the boat and vapor phase hydrogen, there is a small region in the boundary layer around the heated metal filament which should contain sufficient concentrations of both H-atoms and K+ ions for hydrino formation to occur.

Calorimetric considerations require that a stable baseline exists before the heat generating process is initiated. Thus, signal change away from the baseline can be correlated to the onset of the process under investigation. In the present experiments the cell was run with KNO3 in the boat and the filament fully 'powered'. The calorimeter was allowed to equilibrate until a steady baseline existed. The 'hydrino formation' process was initiated by then adding gaseous hydrogen. Good calorimetric practice also requires that adequate control studies be carried out. Also required are repeated electric calibrations.

In the present work, data is presented which indicates that significant heat evolved upon the introduction of hydrogen to the Calvet calorimeter cell. In contrast, no heat was evolved upon the admission of helium. Repeated calibrations were also conducted. Thus, it appears that The RM





hypothesis is supported by the present results. A more definitive statement must await repeats of these experiments, and the results of a few additional control experiments.

An attempt was also made to employ the water bath calorimeter (see previous report to HPC) to detect excess heat. Indeed, the positive results of the Calvet study present a staggering challenge to conventional physics. Challenges of this magnitude require enormous experimental support. Thus, evidence of excess heat production from a second type of calorimeter would be useful. Unfortunately, the experiment failed to yield any evidence of excess heat. However, there is reason to believe that catalyst concentration was low and thus the failure to observe excess heat does not disprove the Mill's hypothesis.

EXPERIMENTAL SYSTEM

Calvet Calorimeter. The Calvet-type calorimeter employed in this study is similar to one described in the literature (attached) and is also described in earlier reports to HPC (now BLP). In essence a stainless steel cup of almost exactly 20 cm³ volume is placed in a calorimeter well such that the cup is surrounded by thermopiles on its sides and bottom. The cup and calorimeter are surrounded by a thick layer of insulation, and the entire device is placed inside a commercial convection oven. In all cases experiments were conducted with the oven temperature set to 250 C.

Reaction cell. For these experiments the top of the calorimeter cup/reactor cell was fitted with a Conflat knife edge flange. The top element of the flange is connected to a gas supply system outside the convection oven with a 0.5 cm OD ss tube, and with two welded vacuum high current copper feedthroughs. The feedthroughs were connected on the cup side of the flange to a coiled section of 0.25 mm platinum wire approximately 18 cm in length. Fitted inside the coiled platinum was a small quartz boat into which 200 mg of powdered KNO3 were placed.

Plumbing. On the outside of the oven the gas feed through is connected to a line leading to hydrogen and helium tanks, a pressure gauge, and a standard vacuum roughing pump. It is notable that the gas lines were all well insulated, both inside the oven, and for about 50 cm outside the oven.





The plumbing system was so arranged that the cell could be evacuated, and then isolated from the pump in such a way that hydrogen or helium could be added directly from high purity gas tanks. Great care was taken before the experiments were initiated to evacuate and flush the gas lines several times. It was also determined that the lines held gas pressure, with no loss in pressure, for several days. That is, there were no leaks.

Water Bath Calorimeter. This instrument is described in detail in the previous report to HPC. Two minor modifications were made for the present experiment. First, to facilitate the decomposition of hydrogen, the center section of the mandrel was wrapped with a 60 cm length (about 8 cm of mandrel) of 0.25 mm diameter platinum wire. Second, in the center of this section the same quartz boat (again filled with about 200 mg of catalyst) used in the Calvet system, wrapped with the same coil of platinum wire, was inserted into the circuit. (The experiment described was carried out after the completion of the Calvet system experiments.)

RESULTS

<u>Calvet Calorimeter</u>. The Calvet studies suggest large amounts of heat are generated upon the admission of hydrogen to the cell. In contrast, virtually no heat is observed upon admission of helium to the cell.

Calibration. The first tests performed on the Calvet system were electrical calibration experiments. The system was set-up for full experimentation: KNO3 was in the boat, the system was evacuated, and 10 watts of steady power were supplied to the platinum coil. After a steady baseline was achieved (approximately 10 hours after the oven was adjusted to 250 C), the cell was isolated from the pump and the pressure allowed to equilibrate (approximately 100 Torr). This did not appear to impact the baseline in any fashion. The power supply was then adjusted to deliver an additional 1 watt (11 watt rather than 10) for a specified time period. The power was then returned to the original 10 watt setting. A typical response curve is shown in Figure 1. The area under the response curve can be used to obtain a calibration constant which relates signal area increase to the number of extra Joules delivered. This was done in four cases (Table I). As can be seen, there is some error (+/- 15%) in the calculated calibration constant.





Control Studies. Helium was admitted, approximately 10 psig, to the cell to test the impact of a change in pressure, and heat transfer characteristics on the response of the cell. The helium was admitted after the cell had been isolated from the pump for a considerable time and a steady pressure (approximately 100 Torr) achieved. As can be seen in Figure 2a, the response was a short-lived small increase in output signal, followed by a relatively short time period during which the signal gradually returns to the original baseline. Within an hour the signal returned to the original baseline, with some drift evident.

The response of the system is expected. The helium increases the rate of heat transfer away from the platinum filament, and heated boat. Thus, the initial addition of helium to the system results in a temporary increase in the amount of heat reaching the thermopiles. That is, the boat and the filament cool off, until such time as the boat and filament have reached their new steady state temperatures. The steady state temperature of boat and filament are a function of heat transfer mechanism. After the admission of helium most heat transfer is occurring by convection to the walls. Before the admission of helium a considerable fraction is by radiation. Radiative transfer of 10 watts requires a higher filament/boat temperature than does convective heat transfer.

Figure 2b illustrates again the impact of adding pressure, or removing gas, from the system. Upon the addition of helium there is a very short lived increase in heat reaching the thermopiles. Upon pumping there is a period of time, perhaps an hour, during which the heat signal goes below the baseline. This is consistent with the model in that pumping makes convective and diffusive heat transfer minimal. Virtually all heat transfer is by radiation, which requires that the filament/boat temperature increase. It takes some time for this new steady-state temperature to be reached.

Hydrogen Admission. Hydrogen admission was carried out in much the same fashion as helium admission. The cell reached an equilibrium pressure, approximately 100 Torr, and then hydrogen at 10 psig was admitted to the cell. The valve to the hydrogen source, which was a steel line 4 meters by 0.6 cm OD, was closed off by a valve in front of the regulator during admission. Moreover, it was open for only a couple of seconds in each case. This was done on three separate





occasions, and the signal that evolved in response to these three processes is recorded in Figures 3, 4 and 5. One other observation recorded was that the pressure decreased gradually over time, such that after about an hour the pressure returned to the original equilibrium pressure of the cell. It must also be noted that the heat production was ended deliberately in all three cases by pumping the system to 5*10⁻³ Torr. It is clear 'excess heat' evolution would have continued in all cases if the system had not been evacuated.

It is expected that in the absence of reaction that the response of the cell to the addition of hydrogen would be similar to that observed for helium. Indeed, given that pressure measurements suggest that most hydrogen is adsorbed, or in some other fashion removed from the cell after an hour, even heat transfer effects should be totally transitory. Even in the event of reaction no more than a small heat signal is expected. Indeed, a high end estimate is that 25 cm³ of hydrogen at a temperature of 300 K and a pressure of 2 atmospheres entered the cell. This is equivalent to 2*10⁻³ moles of hydrogen. If all of that hydrogen interacted with oxygen to form water only 510 J would be generated. It is possible to imagine that the hydrogen could interact with nitrogen in KNO3 to form ammonia. Even less energy would evolve from this process. Thus, the largest heat peak might be expected to be 0.5 watts for 1000 seconds (approx. 17 minutes). A block of this size is marked on Figure 3.

It is clear from figures 3, 4 and 5 that hydrogen admission to the cell apparently leads to far more energy evolution than can be explained by any conventional chemical process. It is interesting in this regard to graphically contrast the response of the system to helium admission to the response to that for hydrogen admission. This is done on Figure 6 in which Figure 3 and Figure 2a are superimposed.

Water Bath Calorimeter. Studies conducted with the water bath calorimeter do not indicate the evolution of any excess heat. As shown in Figure 7 the increase in temperature almost exactly parallels the increase predicted on the basis of the amount of energy added to the system and the known heat capacity of water.





Do the results of the experiment refute the RM hypothesis? No. At the conclusion of the experiment the large cell was removed from the water bath and a white coating was seen on the walls in the vicinity of the pot which contained the KNO3. This suggests that the KNO3 was rapidly cryopumped by the walls, and that the gas phase concentration of catalyst was too low to be effective.

DISCUSSION

The evidence presented in this report clearly suggests that an extraordinary phenomenon takes place upon the admission of hydrogen to a cell containing a heated platinum filament and KNO3. This phenomenon appears to generate a tremendous amount of 'excess' heat. Still, the author of this report urges that a cautious approach be taken at present. Additional experimental work is required. A partial list of proposed additional experiments is given below:

- 1) A control experiment consisting of admission of hydrogen to a cell in which 10 watts of power is applied to a platinum filament, but no KNO3 is present.
- 2) Hydrogen is admitted to a cell containing a platinum filament and KNO3 in a boat, but no power is applied to the filament.
- 3) The experiments are run as described in the present report, but the boat containing KNO3 is at the bottom of the cell, rather than in the center of the platinum coil.
- 4) The hydrogen admission experiments described above are repeated BUT continued for times sufficient to return the signal to the original baseline.

In addition, modifications in the apparatus should be made. First, insulation should be added to improve the stability of the baseline. Second, a quality pressure gauge should be attached to a known volume outside the oven such that all uncertainty regarding the number of moles of hydrogen admitted to the cell can be eliminated. Third, the plumbing should be re-arranged to facilitate 'capture' of gas for analysis using gas chromatography. Fourth, provision should be made to permit pressure to be recorded as a function of time.









Typical Calibration Experiment: 1 W Input, 20 Mins

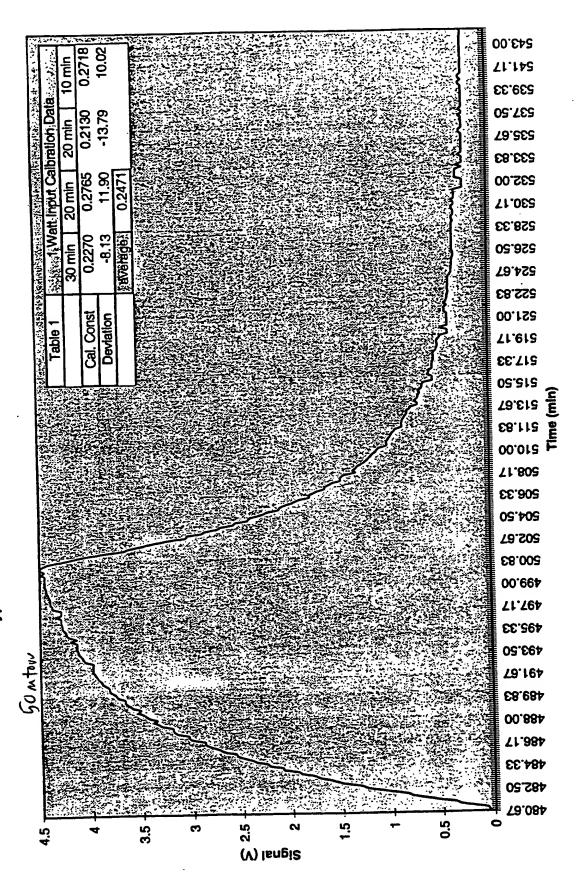
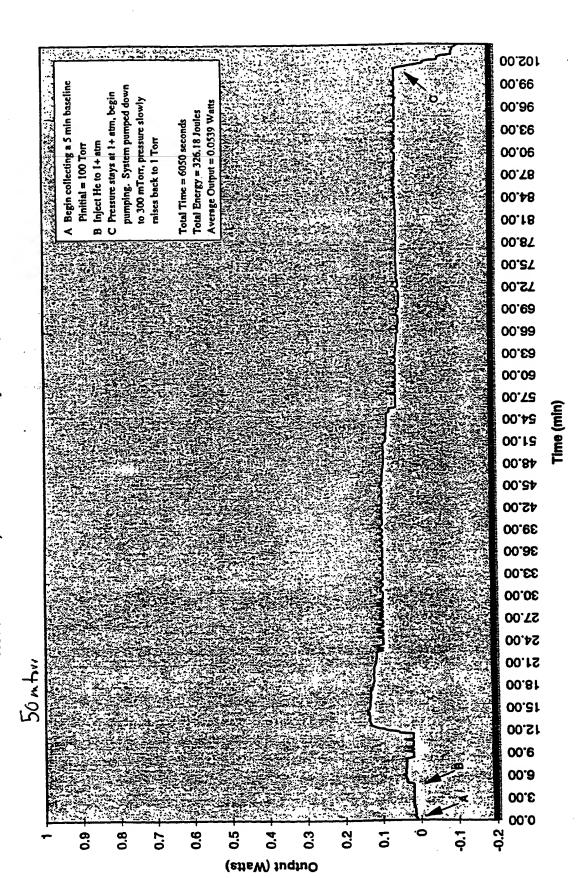


Figure 1





Heat Production, KNO3 w/ Helium Injection (BL1220A)



A C. C. C. C. C.

Now. of







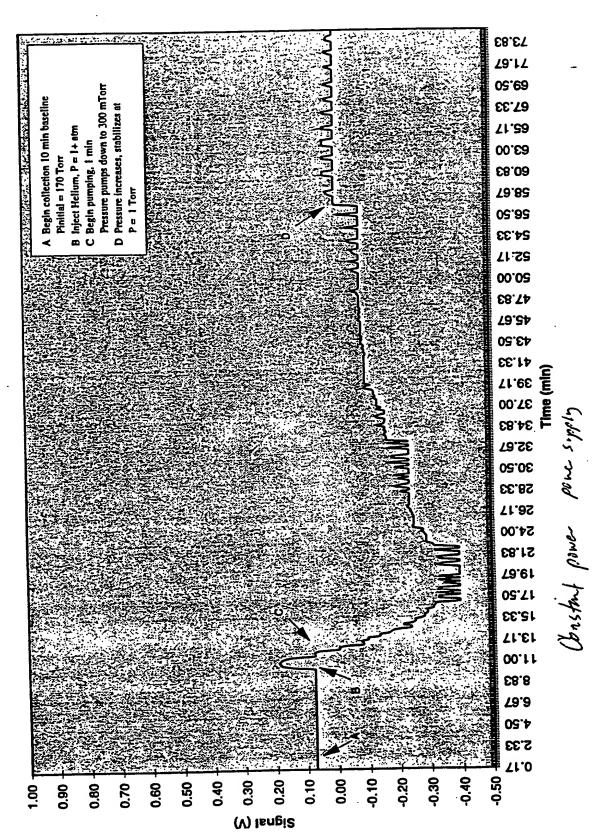
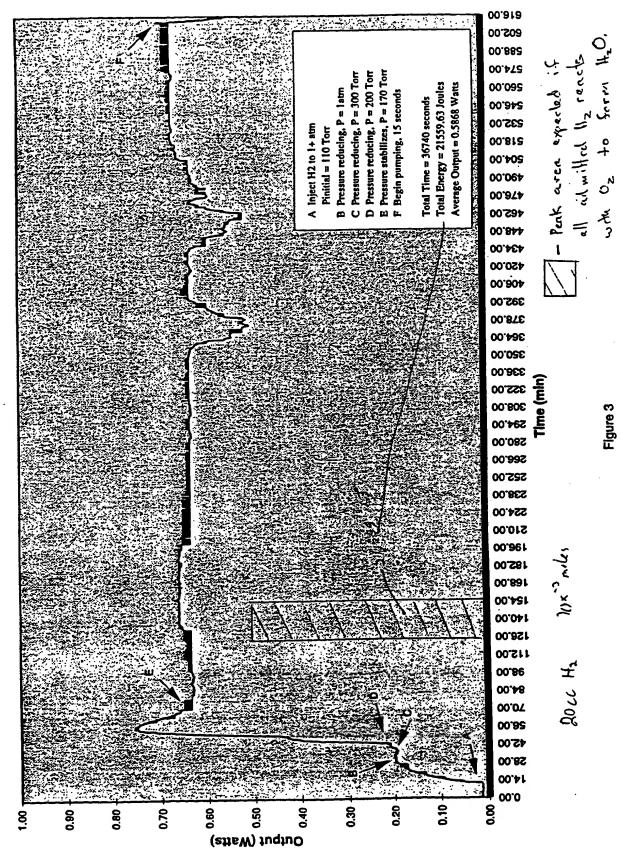


Figure 2B

Heat Production, KNO3 w/ H2 Injection (BL1218CD)



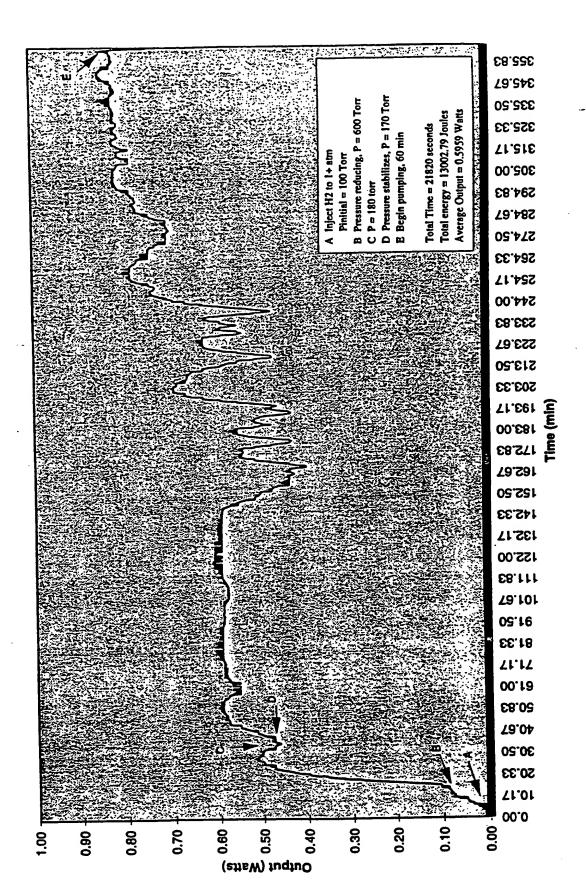








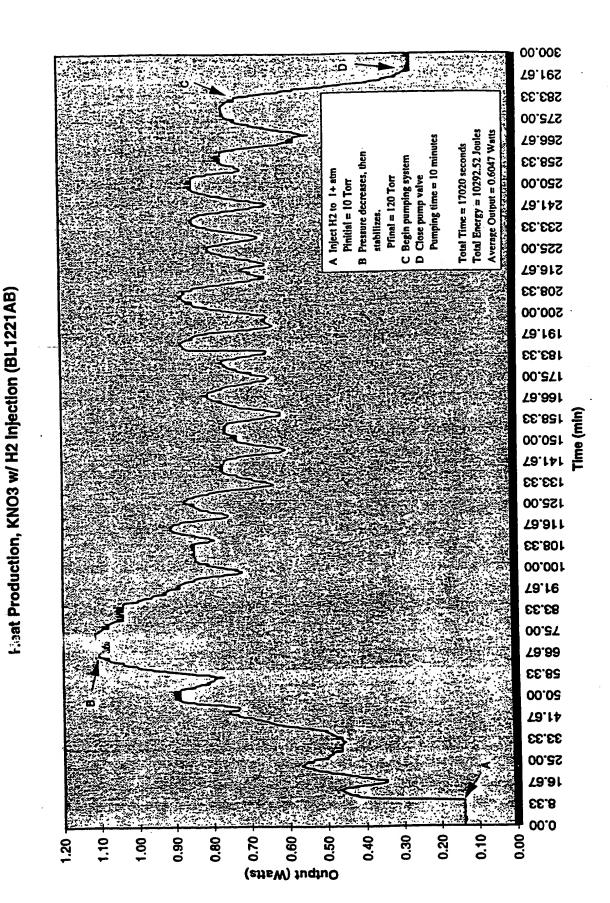
Heat Production, KNO3 w/ H2 Injection (BL1220BC)









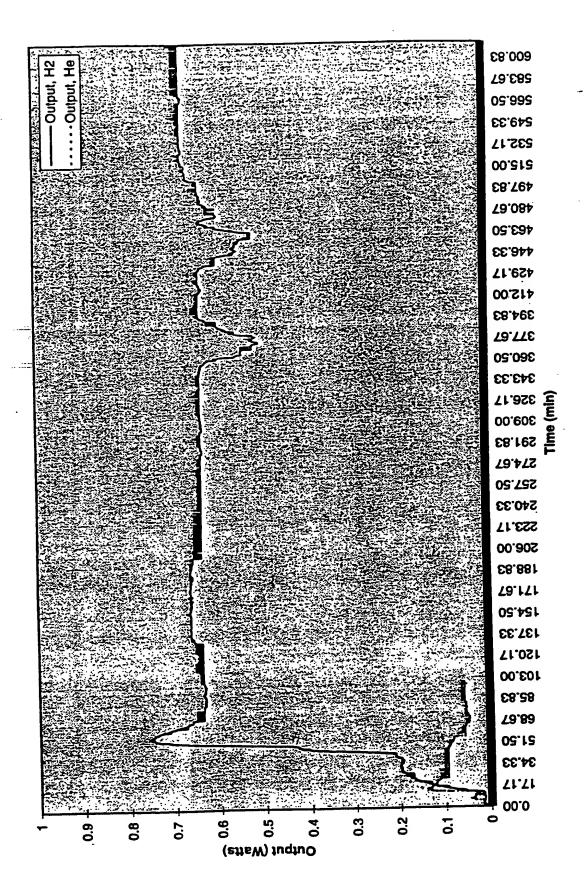


ioure 5



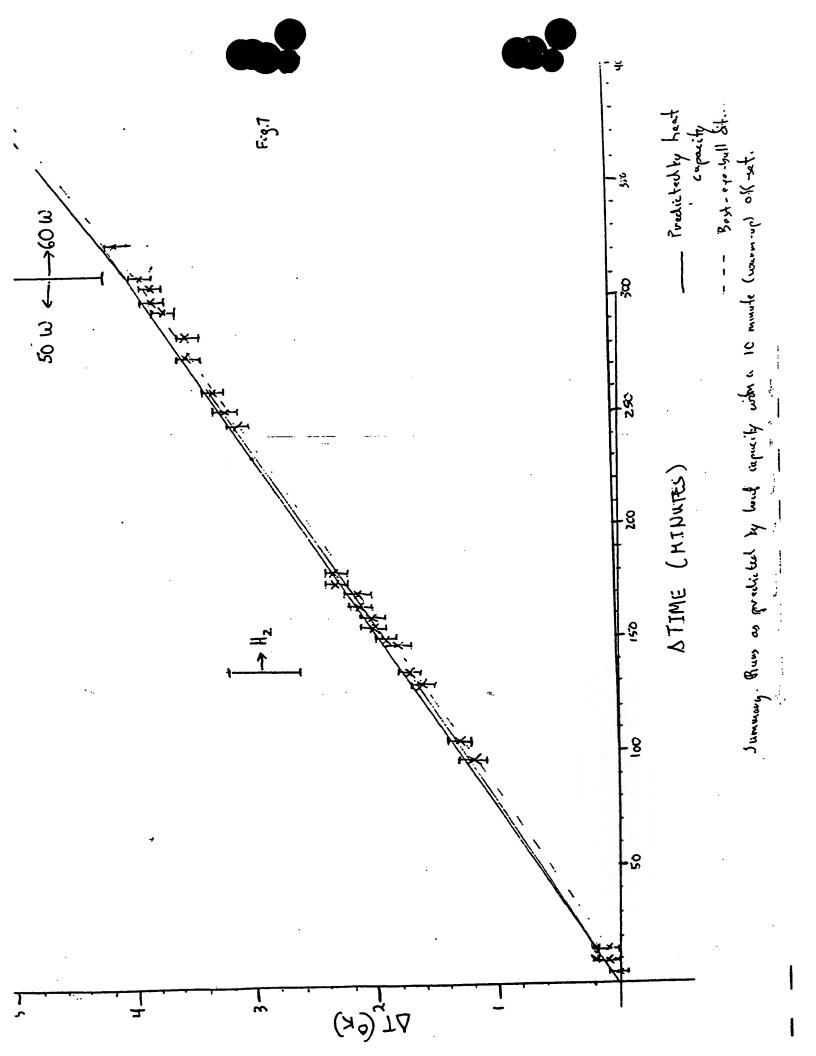


Heat Production, KNO3 w/ H2 and He Injection (BL1218CD,BL1219B)

















acourte de

et regular

THESIS - APPENDIX SEVEN

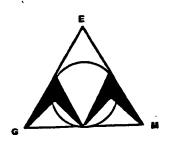








FINAL REVISED 12 APRIL 1997



BLACKLIGHT POWER CORPORATION

EXPERIMENTAL PROTOCOL FOR CALVET HEAT MEASUREMENTS OF A HIGH TEMPERATURE VAPOR PHASE CELL

EXPERIMENTS BY P.M. JANSSON, P.P., P.E.
B.S.C.E MASSACHUSETTS INSTITUTE OF TECHNOLOGY '78
FOR M.S.E. THESIS AT ROWAN UNIVERSITY '97

TO DETERMINE FILAMENT SURFACE AREA EFFECTS ON HEAT GENERATION

3 March 1997 - 20 April 1997

Experiments Conducted in Laboratory of:

BLACK LIGHT P O W E R inc.

Great Valley Corporate Center 41 Great Valley Parkway Malvern, PA 19355









CALVET HEAT MEASUREMENTS OF THE HIGH TEMPERATURE VAPOR PHASE CELL

Objective

A number of experimental observations from BlackLight Power and Pennsylvania State University lead to the conclusion that atomic hydrogen can acheive fractional quantum states that are at lower energies than the traditional "ground" (n =) state which form the basis of a new hydrogen energy source. Certain inorganic ions which are proprietary to the BlackLight Power serve as transition catalysts which resonantly accept energy from hydrogen atoms and release the energy to the surroundings. The reaction of hydrogen to lower-energy states is referred to as a transition reaction. The transition catalyst should not be consumed in the reaction. It accepts energy from hydrogen and releases the energy to the surroundings. Thus, the transition catalyst returns to the original state. And, the energy released from hydrogen atoms is very large compared to conventional chemical reactions including the combustion of hydrogen. Multiple cycles of catalysis are possible with increasing amounts of energy with successive cycles of transitions.

The goal of this project is to perform precise Calvet calorimetric measurements of a hydrogen gas energy reactor wherein the predicted exothermic reaction of electronic transitions of hydrogen to lower energy states could be measured. This new reaction occurs in the gas phase of atomic hydrogen. If successful, the experiments should produce statistically significant excess heat much greater than any known chemical reactions for hydrogen. The experiment will also vary the size [length] of the platinum filament used in the reactor to dissociate the hydrogen molecules to make hydrogen atoms available for the anticipated catalytic transition to reduced energy states. The intent will be to demonstrate that heat generation from this reaction will be directly related to available hydrogen atoms, which should be generated at different rates by varying filament size while keeping all other controllable parameters constant [ie; filament temperature, partial pressure of the catalyst, partial pressure of the H2 gas, vessel temperature and pressure, etc.]

Vapor Phase Energy Cell

The hydrogen gas energy reactor wherein the exothermic reaction of hydrogen occurs in the gas phase comprises a vacuum vessel; a source of hydrogen; a means to control the pressure and flow of hydrogen into the vessel; a material to dissociate the molecular hydrogen into atomic hydrogen, and a transition catalyst. The hydrogen transitions occur by contact of the hydrogen with the transition catalyst such that the resonant energy transfer occurs. catalytic reaction rate is maximized in the gas phase. The gaseous transition catalyst includes ions that sublime, boil, and/or are volatile at the elevated operating temperature of some regions of the gas energy reactor. In this project, the source of hydrogen atoms in the gas phase comprises an external tank of pressurized hydrogen gas at room temperature conditions.

Volatilized Transition Catalyst, K^* / K^* , in a Gas Cell for a Calvet Calorimeter

The transition reaction occurs in the gas phase. Gas phase hydrogen atoms are generated with a high purity platinum filament. The general cell schematic is shown in Figure 1. The cell comprises a 20 cc stainless steel vessel capable of containing a vacuum or a pressure





above atmospheric. The cell is maintained at an elevated isothermal temperature by a forced convection oven. The operating temperature of the convection oven [and gas cell when no filaments are energized] is 250°C. The cell is used in the vertical position and is inserted into a thermopile [13]. The flange [4] is sealed with a copper gasket [8] that has had its surface oxidized and softened by direct heating with a propane torch or oven. The flange has a two hole Conax-Buffalo gland [6] for the leads [5] of the filament that is present during the calibration of the cell and varied in length for the experiments 1-3 of the reaction vessel. The flange [4] also has a 1/4" vacuum port through which the hydrogen is passed. The vaccum port connects to a Tee [3], a OE bellows valve, a pressure gauge, and then the hydrogen supply. The elbow port of the Tee [3] is attached to vacuum gauges, a bellows valve, and then a vacuum pump. The filament is platinum wire [0.25 mm. diameter] of 99.99% purity. The lengths of the filament [and resulting surface areas] are varied 20cm, 10cm and 30cm for experiments 1 through 3 respectively.

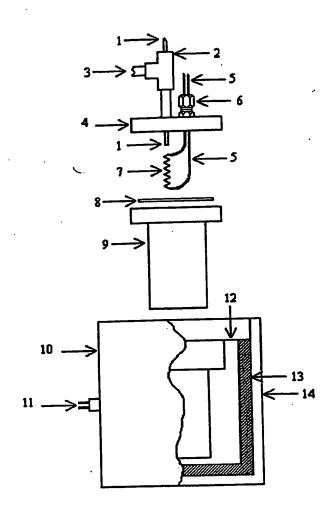
A small ceramic vessel is secured at the base of the Calvet cell [by a nickle wire stand] which contains the catalyst potassium nitrate (KNO3). A vacuum is pulled on the cell while the oven is brought to operating temperature. The appropriate power is dissipated in the filament at an established rate calculated to keep the filament surface temperature constant [10watts for 20cm., 5 watts for 10cm., 15 watts for 30cm.] The oven maintains the surrounding ambient temperature at 250°C. The catalyst's vapor pressure is observed as a function of temperature, and once Calvet cell reaches its steady state output at the supplied input energy, the vacuum pump is stopped and the catalyst pressure within the outlet tube [3] is observed to be constant in the range of about one-hundred to two-hundred torr. Hydrogen gas is then added to the cell to bring its overall total static pressure including the hydrogen pressure measured in the outlet tube [3] by the vacuum gauge to be 3 times the stable pressure of the catalyst (KNO3). The data is recorded with a Macintosh based computer data acquisition system (Apple Quadra 800) and the following National Instruments, Inc. hardware: Lab-NB Data Acquisition Board; Back-Plane with amplifiers: (2) 10 mV to 5 V and (2) 50 mV to 5 V.

NOTE: Minor Edits to Figure 1 below need to be made.





Figure 1. Schematic of the Gas Cell for the Calvet Calorimeter and Cross Sectional View of the Calvet Calorimeter. 1 - (1/16)" OD stainless steel tube (to hydrogen supply), 2 - stainless steel tee union, 3 - (1/4)" OD stainless steel tube (to vacuum manifold), 4 - cell lid, 5 - filament leads, 6 - Conax-Buffalo gland, 7 - precision resistor, 0.1 mm OD tungsten filament, or nickel hydride filament treated with catalyst, 8 - copper ring gasket, 9 - cell body, 10 - Calvet Calorimeter, 11 - thermopile signal output, 12 - thermal shunt, 13 - thermopile, 14 - insulated calorimeter base.







Sequence of Controls and Experiments

Control #1

Install 20 cm Platinum [Alfa] filament, 0.25mm diameter in Reaction Vessel

Warm up oven Temperature 250°C.

Filament input wattage = 0

Vacuum down pressure in Reaction Vessel below 10 mtorr to remove moisture.

Stabilize Oven and Vessel Temperature to 250°C.

Close all valves and vacuum pump.

Inlet H2 gas to 650 torr pressure.

Run Calibration #1 through full sequence allowing Calvet Cell to reach steady state output [Vc]

for each power level shown below:

0 watts, 10 watts, 11 watts, 5 watts, 6 watts, 15 watts, 16 watts, 0 watts, 1 watt.

Develop 'BEFORE' Calibration Curve.

Experiment #1

Install New 20 cm Platinum [Aldrich] Filament [99.99% purity], 0.25 mm diameter

Weigh approx. 0.25 grams of KNO3 and place in ceramic boat

Support boat via nickle wire support legs

Reassemble reaction vessel

Pressure check Calvet and all gas & vacuum lines

Insulate Calvet Calorimeter close oven

Warm up oven Temperature 250°C.

Filament input wattage = 0

Vacuum down pressure in Reaction Vessel below 10 mtorr to remove moisture.

Close all valves and vacuum pump.

Stabilize Oven and Vessel Temperature to 250°C.

Observe catalyst vapor pressure steady state [100-200 torr]

Begin Experiment #1 by Increasing Filament Power Level to that shown below:

10 watts

Inlet H2 gas to bring vessel to 3 times overall catalyst steady state pressure. [Ie; if catalyst pressure is 200 torr add 400 torr of H2 gas to bring Calvet to 600 torr.

Wait 5 minutes for mixing to occur.

Slowly vacuum down Vessel to 30-70 mtorr level until excess heat formation commences.

Keep Vessel under vacuum to maintain 'active' pressure regime [ie; 38 mtorr, 70 mtorr, etc.]

Stabilize Readings and Develop Experimental Data Curves.

Save Data Acquisition System [DAS] file daily, using the same standard naming

convention: tpdate[mmddyy] time[930a] watt[7w] id[h]

Take 1 or 2 new data points [controls] to develop specific curve after reaction ceases.

OPTION 1: Close valve to Vacuum to quench reaction if required.

OPTION 2: Repeat experiment if it is believed that catalyst pressure is inadequate or hydrogen atom generation is compromised





Experiment #2

Install New 10 cm Platinum [Aldrich] Filament [99.99% purity], 0.25 mm diameter

Weigh approx. 0.25 grams of KNO3 and place in ceramic boat

Support boat via nickle wire support legs

Reassemble reaction vessel

Pressure check Calvet and all gas & vacuum lines

Insulate Calvet Calorimeter close oven

Warm up oven Temperature 250°C.

Filament input wattage = 0

Vacuum down pressure in Reaction Vessel below 10 mtorr to remove moisture.

Close all valves and vacuum pump.

Stabilize Oven and Vessel Temperature to 250°C.

Observe catalyst vapor pressure steady state [100-200 torr]

Begin Experiment #1 by Increasing Filament Power Level to that shown below:

5 watts...

Inlet H2 gas to bring vessel to 3 times overall catalyst steady state pressure. [Ie; if catalyst pressure is 200 torr add 400 torr of H2 gas to bring Calvet to 600 torr.

Wait 5 minutes for mixing to occur.

Slowly vacuum down Vessel to 30-70 mtorr level until excess heat formation commences.

Keep Vessel under vacuum to maintain 'active' pressure regime [ie; 38 mtorr, 70 mtorr, etc.]

Stabilize Readings and Develop Experimental Data Curves.

Save Data Acquisition System [DAS] file daily, using the same standard naming

convention: tpdate[mmddyy] time[930a] watt[7w] id[h]

Take 1 or 2 new data points [controls] to develop specific curve after reaction ceases.

OPTION 1: Close valve to Vacuum to quench reaction if required.

OPTION 2: Repeat experiment if it is believed that catalyst pressure is inadequate or hydrogen

atom generation is compromised

Experiment #3

Install New 30 cm Platinum [Aldrich] Filament [99.99% purity], 0.25 mm diameter

Weigh approx. 0.25 grams of KNO3 and place in ceramic boat

Support boat via nickle wire support legs

Reassemble reaction vessel

Pressure check Calvet and all gas & vacuum lines

Insulate Calvet Calorimeter close oven

Warm up oven Temperature 250°C.

Filament input wattage = 0

Vacuum down pressure in Reaction Vessel below 10 mtorr to remove moisture.

Close all valves and vacuum pump.

Stabilize Oven and Vessel Temperature to 250°C.

Observe catalyst vapor pressure steady state [100-200 torr]





Begin Experiment #1 by Increasing Filament Power Level to that shown below:

Inlet H2 gas to bring vessel to 3 times overall catalyst steady state pressure. [Ie, if catalyst pressure is 200 torr add 400 torr of H2 gas to bring Calvet to 600 torr.

Wait 5 minutes for mixing to occur.

Slowly vacuum down Vessel to 30-70 mtorr level until excess heat formation commences. Keep Vessel under vacuum to maintain 'active' pressure regime [ie; 38 mtorr, 70 mtorr, etc.] Stabilize Readings and Develop Experimental Data Curves.

Save Data Acquisition System [DAS] file daily, using the same standard naming

convention: tpdate[mmddyy] time[930a] watt[7w] id[h]

Take 1 or 2 new data points [controls] to develop specific curve after reaction ceases.

OPTION 1: Close valve to Vacuum to quench reaction if required.

OPTION 2: Repeat experiment if it is believed that catalyst pressure is inadequate or hydrogen atom generation is compromised

Control #2

Install New3 20 cm Platinum [Aldrich] filament [99.99% purity], 0.25mm diameter in Vessel Warm up oven Temperature 250°C.

Filament input wattage = 0

Vacuum down pressure in Reaction Vessel below 10 mtorr to remove moisture.

Stabilize Oven and Vessel Temperature to 250°C.

Close all valves and vacuum pump.

Inlet H2 gas to 650 torr pressure.

Vacuum down to 40-100 mtorr range.

Run Calibration #2 through full sequence to steady state at each power level shown below: 0 watts, 10 watts, 11 watts, 5 watts, 6 watts, 15 watts, 16 watts, 0 watts, 1 watt. [add any new points determined via Experiments 1-3 then repeat sequence above]

Develop 'AFTER' Calibration Curve.

Compare Calibration Curves 'Before' and 'After' Analyze and Report on Results Based upon above

final revised 12 April 1997

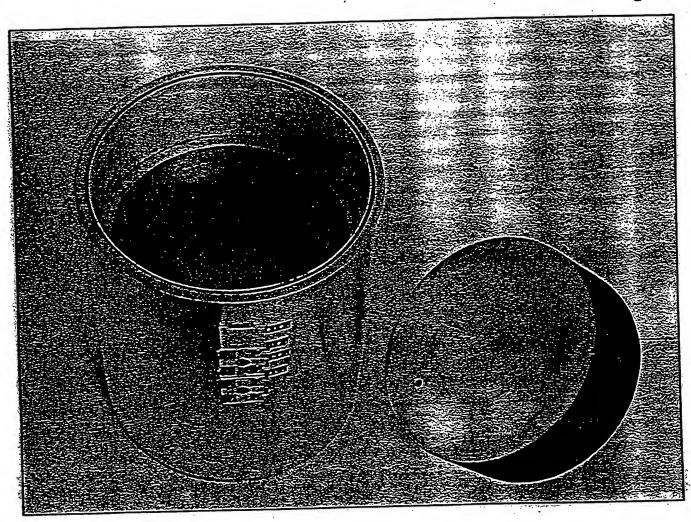
developed by: William Good - BlackLight Power Peter Jansson - Atlantic Energy







RADIOISOTOPE MICEOPALORIMETERS



CR-180 7" Thermoelectric Enclosure

The series CR-100 Microcalorimeters provide an accurate measurement of radioisotope heat release rates.







PRINCIPLE

The thermal gradient calorimeter transfers all the heat developed in a reaction to its surrounding heat sink at a constant temperature. The calorimeter walls thermoelectrically transduce sample heat release into an electrical signal which is directly proportional to the energy release of the source. Transient as well as steady state energy releases may be measured.

FEATURES

- · Whole body heat release measurements
- Microwatt to kilowatt sample output
- · High sensitivities and repeatability
- · Linear output
- Transient and steady state response
- · Wide temperature range
- · Simple "In-situ" recalibration
- No excitation required

SPECIFICATIONS

•		
	ber wolume range: 1900 in ^a	
Sensitivities: to 15 m	illiwatts per millivolt	
Temperature Oryogen	range: ic to 600°F	
Response tin 10 sec.	ês: to 10 min.	
Vacuum: to 10 ⁶ 1	orr.	
Sutput imper 10Ω to		•
Accuracies: to 0.5%		

Power supply:

Repeatability:

0.01%

not required

Materials

Aluminum, stainless steels, copper, composites

CONSTRUCTION

The calorimeter walls are composed of a thin, high temperature thermopile structure containing thousands of junctions. One set of junctions is in

thermal contact with one wall surface, and the other set is in contact with the opposite surface. As heat flows through the walls, (Fig. 1) a temperature difference is established between both sets of thermopile junctions, thus generating a voltage which is directly proportional to the heat flow. The large number of ther-

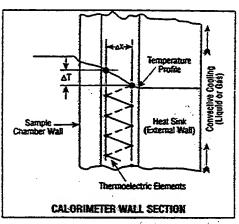


Figure 1

mopiles develop extreme sensitivity to minute heat flows. Calorimeters are constructed in a range of designs incorporating large sample chambers for high heat fluxes (cover) or small sample chambers capable of measuring low heat releases (Figure 2).

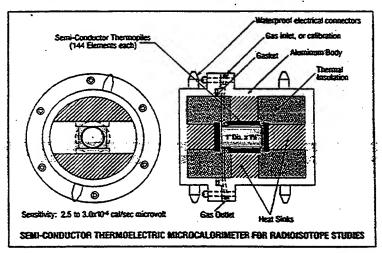


Figure 2

CALIBRATION

Each calorimeter is calibrated at a base temperature of 70° F by a known, electrical heat source in thermal equilibrium with the system.

The calibration constant is expressed in terms of wattage input versus millivolt output. A temperature correction curve is also supplied for use at elevated temperatures.





APPLICATIONS

The CR-100 Series calorimeters are designed to measure both microcaloric and macrocaloric heat release from pure or mixed radioisotopes. The magnitude of the generated signal is strictly proportional to the mean intensity of the sample.

Other applications include: physical, chemical and biological thermogenesis, specific heats, heats of fusion and reaction.

EXAMPLE OF OPERATION

Reactive materials are placed in a suitable container within the calorimeter sample chamber and permitted to reach equilibrium. To decrease the equilibrium time, it is desirable to heat sink the container to the sample chamber wall. The calorimeter should be situated in a constant temperature environment cooled either by gas or liquids. The time required for the calorimeter assembly to attain thermal equilibrium is a function of the conductivity and size of the sample, the thermal contact at the sample chamber wall, calorimeter wall characteristics, and the external cooling rate.

At thermal equilibrium, the output signal will reach a mean steady state value which is proportional to the total heat release from the sample. With the known calibration constant (milliwatts/millivolt), the total heat liberation rate is accurately determined. For radioisotopes with mean decay rates greater than calorimeter response time, the signal is proportional to radioisotope sample decay (Figure 3).

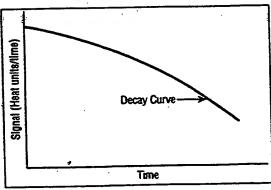


Figure 3

MICROWATT DETERMINATIONS

To measure microwatt heat flow accurately, it is necessary to provide a stable, cooling environment.

However, most constant temperature cooling baths exhibit small fluctuations which may generate signals the same order of magnitude as those produced by the sample. To avoid this large noise to signal ratio, a temperature compensated enclosure has been developed (Figure 4). This double

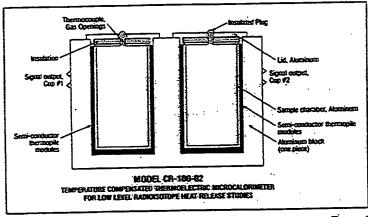


Figure 4

cup system contains both an active and passive chamber having matched sensitivities in opposition. Thus, spurious, external temperature fluctuations are compensated for, and only the heat release from the sample source is detected.

COMPENSATED MICROCALORIMETER SPECIFICATIONS

ample chamber series: 1"-6" Dia. x 1"-12" Depth
ienstraty. 16-15-millwatts/millwolf.
Materials: Aluminum, composites, semi-conductor elements
Calibration: 196 Acc.
Sample chamber matching: Wathin 1/2%
luterual resistance: 10-7500Ω
Readout required: Millivolt potentiometer/Recorder
Environmental requirements: Ambient temperature operation/Constant temperature bath





STANDARD MODELS, SINGLE CHAMBER

Model	Internal D	imensions	External D	imensions	Accuracy	Sensitivity,	Nominal	Temperature	
Number	Diameter, In.	Depth, in.	Diameters, In.	Length, In.	%	Milliwatts per Millivolt	Output Resistence	F° (Note 1)	Response Time, Min.
CA-100-1	1	1	3	3	1%	15	4	250*	1
CA-100-2	2	4	4	6	1%	15	10	250*	1
CA-100-4	_. 4	8	5	12	1%	250	2000	600	3
CA-100-8	8	16, 32	9	21	1%	250	4000	6 00	3
CA-100-C	Custom	Custom	Custom	Custom	1%	250	Varies	600	Varies

Models CR-100-1 and CA-100-2 are also available for 600°F operating temperature at reduced sensitivities.

READOUT INSTRUMENTATION

Suitable readouts for all CR-100 models include: millivolt potentiometers/recorders, data loggers, or conventional D.C. millivolt meters.

ORDERING INFORMATION

Delivery :	6-8 weeks, ARO
Shipping weight	5 to 200 lbs
Terms	et 30 days to established customers
F0B	Del Mar, California

OTHER ITI THERMAL INSTRUMENTS

Thermal Conductivity Apparatus, Heat Flux Meters, HEAT-PROBE™, Accelerator target Calorimeters, Radiometers, Thermal Flux Standards.





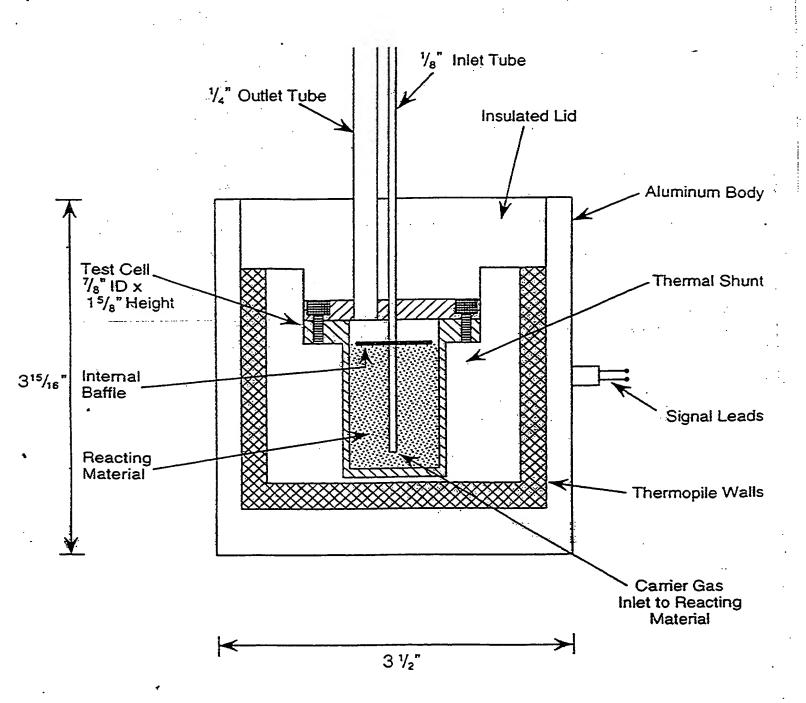


Figure 1. Scale Drawing of Calorimeter Assembly

K-404-01-mg



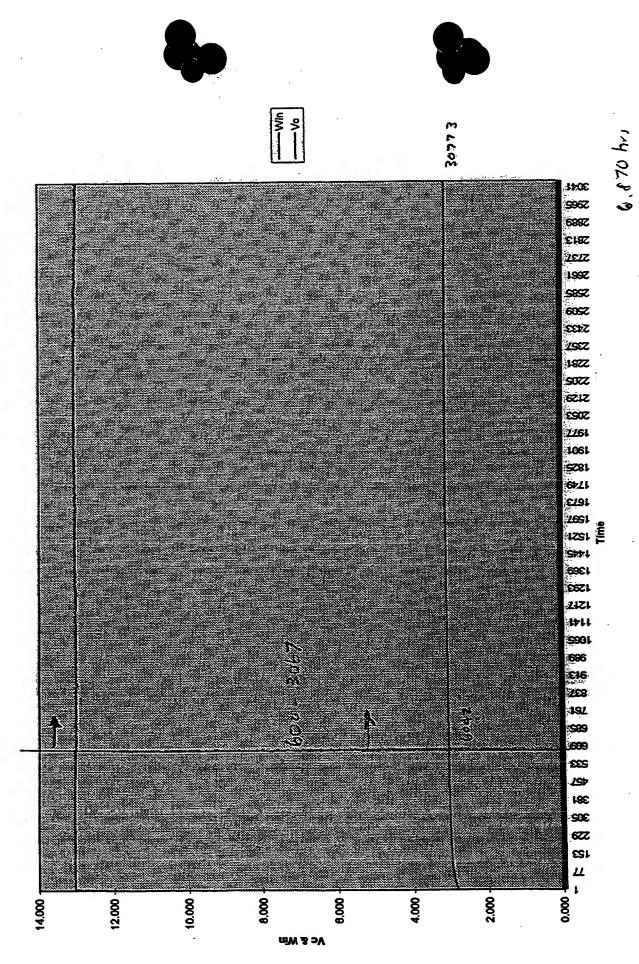






March 5 - March 10, 1997

					1
Win	Predicted Vc				
C	-0:0605	Given Vc=	3.076		┼──
1	0.1728	Estimated			-
2	0.4061	Watts Out	13.444	watts of power	┼—
- 3	0:6394	Actual =		watts of input power	—
<u> </u>	0.8727		0.404	excess watts	↓
	1.106			<u> </u>	
	1.3393				┼
	1.5726				∔
	1.8059				┼
	2.0392				↓—
10	2.2725				┼
1	2.5058			<u> </u>	—
1.					┼
1:					╂
- 14				 	┼
1:					┼
14	3.6723				+
· ·				<u> </u>	╁─
					+-
	1 1			 	+



Page 1



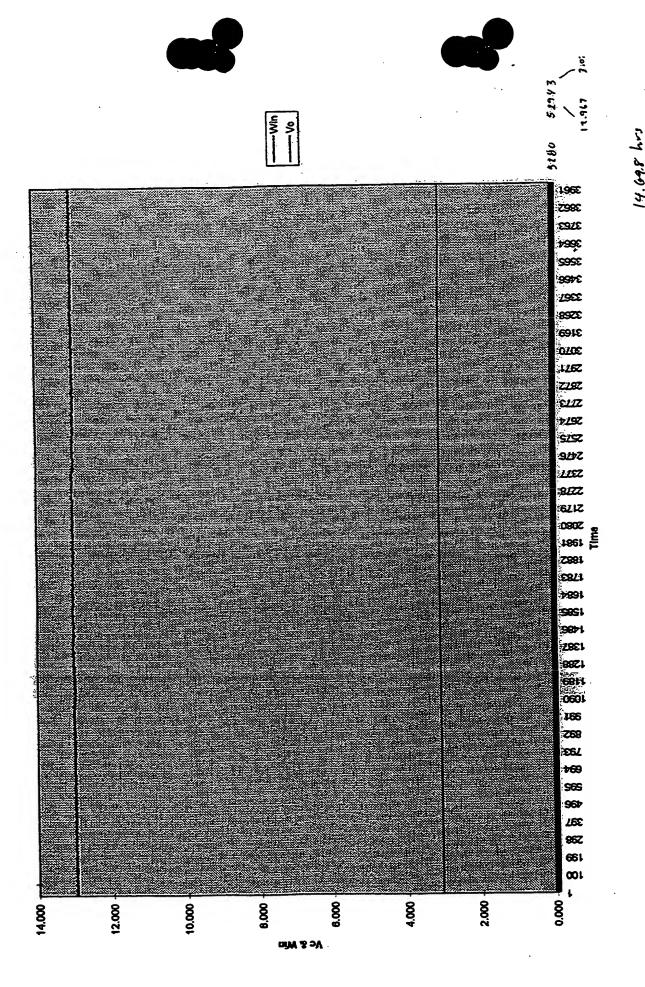


												•		1								
					٠						٠	•										
			Max	3.092	13.077																	
	hrel	To III	WIN.	3,021	1777 CF																	
	SON FAM ROS	00014111007	Std Dev	0.018	PEUU																	
	1 0 V C	3,083 Statistics from 2 to 0200 [14,000 iiis	Average Std Dev Min	3.078	40,007	1																
	10.00	Statistics 1		3		Min																
- N	3		3.083	2 082	3,000			3,083	3,084	3,084		١	j	3.084	2 083	1		3,083	3.083			3,083
1111	1	13,003		.1	ı.		12.982		13.017	1	1	- 1	- 1	12.971	1	1		13.013	12 973		12.954	13.010
13%	X	0.280	0.280	200	0.200	0.280	0.260	0.280	0.260	0.259	0800	0.200	0.260	0.259	Vac o	0,500	0.280	0.280	0 260	0.400	0,280	0,280
	V¢.	0.617	0 A17	200	0.817	0.617	0.817	0.817	0.817	0 A17	1000	0.017	0.617	0.847	2000	0.017	0.617	0.817	1000	0.0	0.617	0.617
	\chi_	3.083	000	3.000	3.083	3.083	3.083	3.083	3.084	780.6	9.004	3.084	3.084	7 084	2007	3.083	3.083	2 083		3.063	3.083	3.083
F	lime [sec]	32		42	52	82	72	68	6	400	104	112	122	767	*0	143	153	182	2	173	183	193





Win	Predicted Vc				
 0	-0.0605	Given Vc=	3.078		
 1	0.1728	Estimated		1	
 2	0.4061	Watts Out		watts of power	
3	0.6394	Actual =		watts of input power	
 4	0.8727		0.446	excess watts	
 5	1.106				-
 6	1.3393				
7	1.5726				
8	1.8059				
9	2.0392				
10	2.2725				
11	2.5058				
12					
13				·	
14					
15					<u> </u>
16	3.6723				
 					1
!	1	.1		ł <u>. [</u>	1



Page 1





																1			-					
	_			_		$\frac{1}{1}$					-	_					_	-			_	-	-	4
																***************************************	***************************************							
		Max	2,844	12.932				Max	3,113	13.188				Max	3.075	13,087					***************************************			
	hrs		2,792	12,601			8 hrs]	Zig	3,067	13,091			16 hrs]	Min	3.071	12,38		hrs.						
	3.03 Statistics from 130 to 400 [0.752 hrs]	Std Dev	0.011	0.097			3.029 Statistics from 690 to 1120 [1.198 hrs]	Std Dev	0.012	0.021			3.03 Statistics from 1550 to 1735 [0.515 hrs]	Std Dev	0,001	0.052		3,029 Statistics from 2 to 1735 [4.836 hrs]	Std Dev		0,115441			
	rom 130 to	Average	2,802	12.779			rom 690 to	Average	3.1	13.151			from 1550 (Average	3.073	13.02		from 2 to 1	Average Std Dev		13,01462			
	Statistics 1		Ş	Win			Statistics		Vc	Win	•		Statistics		S	Win		Statistics			Win			
Ve	3.03	3.03	3.03 Vc	3.029 Win	3.029	3.029	3.029	3.029	3,029 Vc	3.029 Win	3.029	3.03	3.03	3,029	3.029 Vc				3,029	3,028	3,028	3,028	3,028	3.028
WIN	12,851	12.921	12.882	12,893	12,985	13,006	12,992	12.99	12,983	12,958	12,928	12.88	12,855	12,934	12,983	12,972	12,884	12,925	12,936	12,864	12.912	12:982		12,975
	0.257	0.258	0.258	0.258	0.28	0.28	0.28	0.28	0.28	0,259	0.259	0,258	0.257	0.259	0.259	0,259	0.258	0.259	0.259	0,259	0.258	0.259	0,26	0.28
XC,	0.807	0.607	0.808	0.608	0,808	0.608	0.608	0.808	0,608	0.608	909'0	0.807	0.608	0.608	0.608	0.808	0.608	9090	909'0	0.808	0.608	0.608	909.0	0.608
	3.03	3.03	3.03	3.029	3.029	3.029	3,029	3.029	3.029	3,029	3.029	3.03	3.03	3.029	3.029	3.029	3.029	3.029	3.029	3,028	3.028	3.028	3.028	3.028
Time [sec]Vc	37	47	57	87	77	87	16	107	117	127	137	147	157	168	178	188	198	208	218	228	238	248	258	268





1000	1	Predicted Vc					
Win			Given Vc=	3.016			
	0			- 0.0.0			
	_1	0.1728	Estimated	40.407	watts of po	vor i	•
	2	0.4061	Watts Out	13.187	waus or por	i anne	
	3	0.6394	Actual =	13.015	watts of inp	ut power	
	4			0.172	excess wat	is ·	
	<u>.</u>						
	<u>_</u> 6						
	7	1.5726					
	8	1.8059				· · · · · ·	
	9				ļ		
	10				<u> </u>		
	11						
	12			<u> </u>			
	13						
	14				-		_
	15				 		
	16	3.6723			 		
					 		
			1				├──





_			Max	2,844	45 025	700.71				Max	3,113	13.188				Max	3.075	13.087		
		hrs		2.782	10001	12.501					3.087	13,091			16 hrs]		3.071	12.380		
		3,030 Statistics from 130 to 400 [0.752 hrs]	Std Dev	0.011	1000	780.0		•	3.029 Statistics from 690 to 1120 [1.198 hrs]	Std Dev	0.012	0,021			3.030 Statistics from 1550 to 1735 [0.515 hrs]	Std Dev	0,001	0.052		
		rom 130 to	Average	2 802	100	12.779			rom 690 to	Average	3,100	13,161			rom 1660 l	Average Std Dev	3.073	13.020		
		Statistics f		3)	3	Win			Statistics f		Λg	Win			Statistics !		Vc	MIN		
	%	3.030	3.030	020 6	0000	3.029	3,029	3.029	3.029	3.029	3.029	3.029					3,029	3.029	3.029	3,029
	Z Z	12,851	12021	0000	70007	12.893	12.985	13.006	12.882	12,990	12 983	12.958	12,928	12,880	12.855	12.934	12 983	12.972	12.884	12,925
		0.257	A 25A	020	0.430	0,258	0,280	0.280	0,280	0.280	0.280	0.259	0.259	0.258	0.257	0.259	0.250	0.259	0.258	0.259
	Xc.	0 807	0.807	200.0	0.606	909.0	0.808	909'0	0.808	0.608	O ROR	O GO	O BOB	0.607	0.608	0 AOA	O AOA	O AOA	0.608	0.606
	Λc	2 030	000	0.000	3.030	3.029	3.029	3.029	3.029	3 029	2000	2000	3 020	3 030	2030	2000	0000	3 020	3.029	3.029
	Time [sec] V	12	10	7	24	67	77	87	76	107	447	101	137	147	457	188	7.78	0/1	108	208





1	.]					1
Win		Predicted Vc				
	0	-0:0605	Given Vc	2:802		1
	1	0.1728	Estimated	· • • • • • • • • • • • • • • • • • • •		<u> </u>
	2	0.4061	Watts Out	12.270	watts of power	1:-
	3		Actual =		watts of input power	
	4			-0.509	excess walls	
	5					<u> </u>
	6					
	7					-
	8					
	9					
	10				<u> </u>	
	11				<u> </u>	
	12					
	13				<u> </u>	
	14					
	15					
	16					
					1 1	





araki ka	Allie Later	india mas is				1.5
Win	Predicted	<u>Vc</u>	e de la compania del compania del compania de la compania del compania de la compania del compania de la compania del compania del compania del compania del la compania del compania dela compania del compania del compania del compania del compania de			
 0	-0:0605		Given Vc=	3.4		
 1	0.1728		Estimated			
 2	0.4061	. "	Watts Out		watts of power	
3	0.6394		Actual =	13.151	watts of input power	
 4	0.8727			0.396	excess watts	
 5	1.106					
 6	1.3393					
 7	1.5726					1
8	1.8059					
9						<u> </u>
 10						
11	2.5058					
12						
13	2.9724					
14						
15						
16	3.6723					
						
	1	_	1		1	1





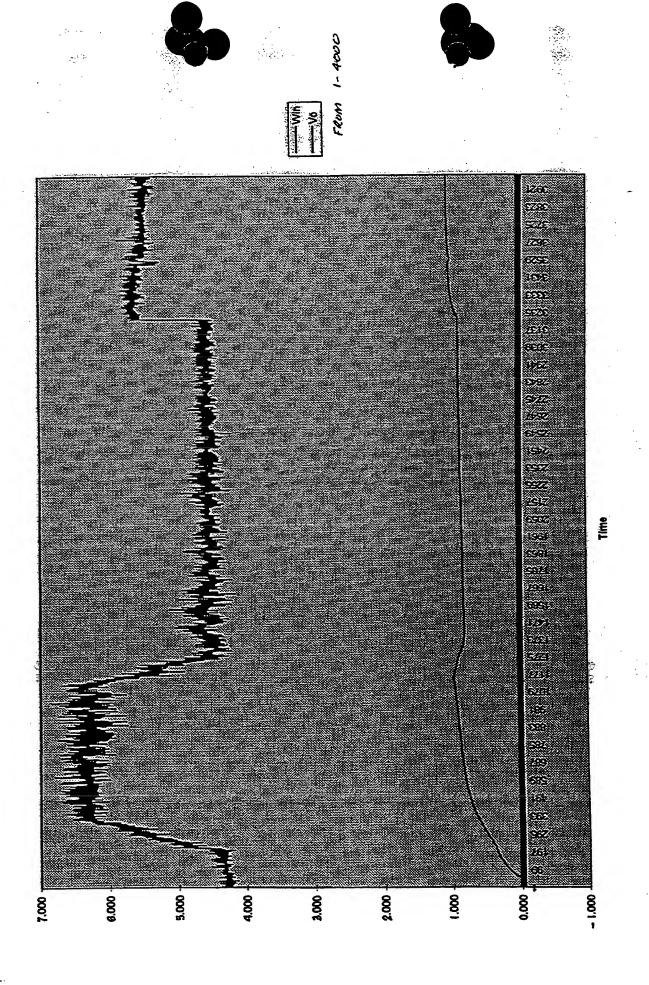
				· ·	and the same of th	
	Transfer and the second	1.447 to 1.44	1			· ·
	7			,	777	
				, 	1	
Win	Predicted Vc			<u></u>		
	0 -0:0605	Given Vc=	3.073	<u></u>		
	1 0:1728	Estimated		**	1	
1	2 0.4061	Watts Out	13:432	watts of po	wer	
	3 0.6394	Actual=	13.020	watts of in	brit bower	:
	4 0.8727		0.412	excess wa	tts	
		-				·
	5 1.106					
	6 1.3393					
	7 1.5726			 		
	8 1.8059			<u> </u>		
	9 2.0392			1	1	
	0 2.2725					
· · · · · · · · · · · · · · · · · · ·	11 2.5058				ļ	
	12 2.7391					
	13 2.9724					
1	14 3.2057				1	
· · · · · · · · · · · · · · · · · · ·					1	
	16 3.6723					•
				1		
						<u> </u>

Page 1

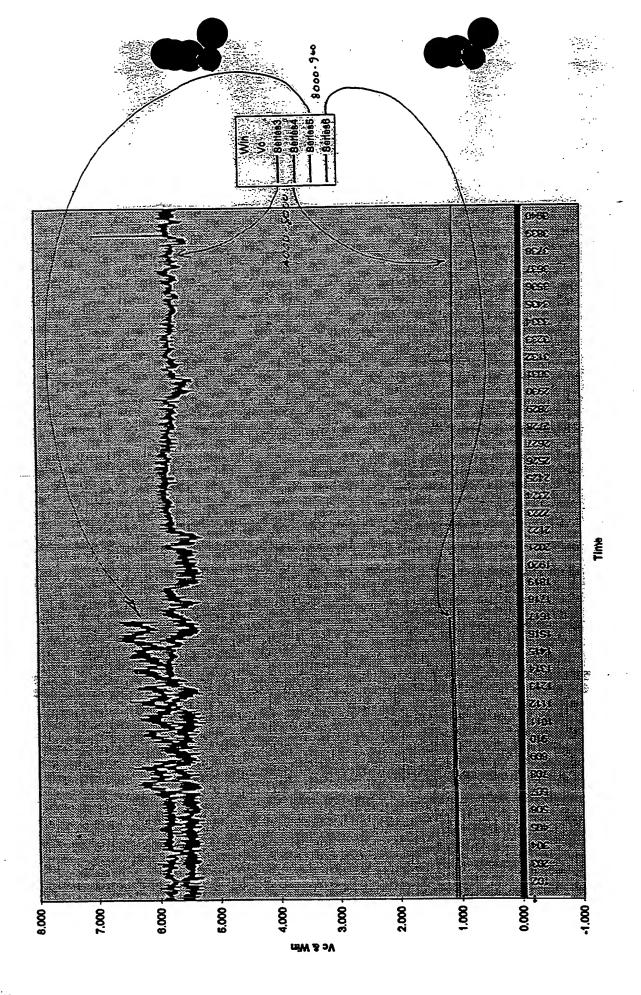


							 332	ز منات		. .				: <u>:</u> :	· i
1											·			The state of the s	Sales Special Sec.
	Max	1.121	7,004												
-	E		5.272			•									***************************************
hrs	8 tq	0,004										-			
8700 [7.518	Average	1.102													
Statistics from 6000-8700 [7.516 hrs]		Λς	Win										-		
Statistics															
Vc	0,000	0,000	0.000	0,000	0.000	0.000				0.000	0.000				0.000
MIN	2.923	0.034	1.190	4.082	4.372	4.278	4,244	4.247	4.272	4,258	4.232	4.252	4.325	4,318	4.290
	0.058	0.001	0.024	0.082	0.087	0.086	0.085	0.085	0,085	0.085	0.085	0.085	0.088	0.086	0.086
×	0.000	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0.000	0.000
'c Vc'	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0000	0000	0000	0.000	0,000
me faeci Vc	100	79	88	66	110	120	130	140	150	160	170	180	180	200	210

Page 1



bage 1



Page 1





30 Centimeter Calibration Run

		March and		many in a lan		.,		
		And the state of t		A Company of the Comp				
	GRAPHIN	G of 30 CM	Control E	xperimenta	l Points			
		172		di la communicación de la	1,,			
		લ		and the same of th				
	Vc	Win	Vc-SD		Date	%-Vc-SD	%-Win-SD	
	3.951		0.004	0.013	29-Apr	0.10%	0.09%	
	3.951			0.010	30-Apr	0.03%	0.07%	
	4.221					0.02%	0.05%	
	4.663			0.007	30-Арг	0.04%	0.04%	0.808
L								
						· ·		
L						<u> </u>	ļ	
]	1	1			<u> </u>	

7																
Statistics for 2981 - 3417. [2] 539 [ITB]	8td Dev	0.004	0.013												·	
0[2881 - 3	Average	3.951	14.943													
Statistics		Λc	Win													
Vc	0.838	0.908	0.971	1			1.139	1.190	1,241	1,294	1.343	1.388	1.431	1.478	1.514	1.548
Vin	15,044	14 983	000 77	Ī	1	15,003	14:957	14,977	147997	14,971	141972	16,041	14,990	14,989	14,980	15,002
	00'0	000	00.0	3	0.00	0.01	0.03	0.04	0.08	0.08	0.11	0.14	0.17	0.21	0.24	0.27
P[L]	0.179	0 175		-	0.168	0.188	0.188	0.164				L				
PIHI	0.549	678	0.040		0.536	0.529	0.529							L		
Win	5 044	2,00	14,803	14.988	15.019	15.003	14.957	14 977	14 997	14 971	14 972	15.041	14 990	14 989	14 980	45,002

30 cm Cartiel

Ve = 3.951

Plot of Vc & Win vs. Time

8.000

Vc & Win

12.000

14.000

16,000

10.000

Page 1

001 eer

0.000

8

000

2.000

		•
		•
1	•	•
-		7

					٠	. ·	<u>داد</u> و								<u>.,.</u>	<u></u>		_	_	_
						-														
	Std Dav	1		0.010438																
Statistics from Points	Average		3.951	14.940																
Statistics f			>	Win																
Λ¢	070 6	0,040	3.950	3.950		OCA'S	3,951	3.951	3.951	200	108.5	3,951	3.951	7.00	LCA'S	3,951	3.951	2 06.4	20.0	CA.S
Wih	700	14.830	14.932	44 DER	2,000	14,952	14,948	14,930	14.914		14.913	14.934	14 938		14.832	14,935	14.934	100 00	179.41	14.927
NUIL	. 1	2,355	2.352			2.352	2,353	2.353	2 363		2,353	2.352	2 252	201	2.353	2,353	2.353	0 0 0	4.333	2.353
1110		0.151	0.158	-	0.147	0.152	0.152	0.159	0 185	3	0.164	0.157	A 4EA	3	0.149	0.148	0.168		0.141	0,162
סומוייי	10 Ki	0,375	N. 975		Uissa	0.355	0.382	0.398	0.448	2	0.415	0.374	030.0	0000	0.343	0.361	0 380		0.317	0,366
MAILE		14.930	44 022	14.02	14.956	14.952	44 94R	14 020	44.044	4.0.4	14.913	14 034		14.830	14,932	14 035	44 024		14,921	14,927
1		0.790	002.0	0.780	0.790	0.790	0 700	700	0.190	0.780	0.790	A 790	2000	0.790	0.790	002.0	2007	0.790	0.790	0.791
		3 949	000	OCA'S	3,950	3.950	2 064	0.60	0.00	3.851	3.951	2 054	0,001	3.951	3.951	2 054	0.001	3.801	3.951	3.951
	Time [8ec] vc	AO I	3 8	QQ Q	9	120		4	001	180	200	000	770	240	280	200	2007	300	320	341

30 cm control Vc = 3.95 1 Win = 14.940

Page 1

April 30, 1997 - 1.7 hours

6**>**Z **S4**# Œ SZ 20,000 9.000 000 16,000 10,000 28.000

Vc & Win

Page 1

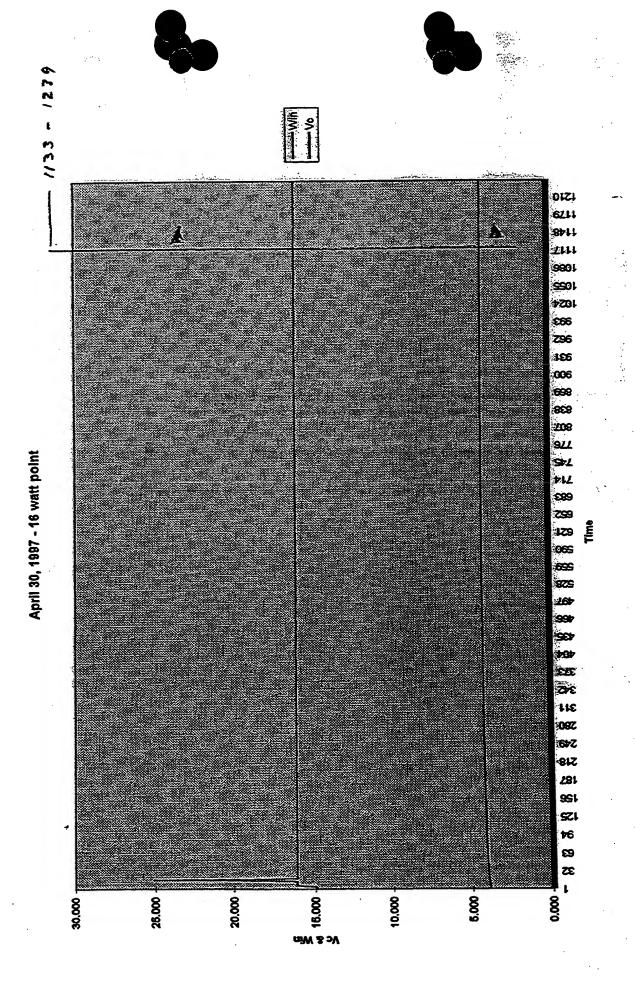
 	•



																				 -		_
16.									-													
Biglietice from Polinis 1133 to 1238 Julian III	Sta Dev	0.00	0.00	2																		7
The Polities 1199	Average	4,221	18 122	1						***************************************												
		ΛC	MIM												2		8	0			9	6
Vc	3.948	3.948			3.948	3.948	3.948	3,950	3,955	3,982	3.989	3.975	١		3,986	3.991	3,996	4,000			1	9:012
Win	14.934	14 031	300	14.949	14.952	14,942	15,487	16,131	18.147	16,159	18.170	18.183	37.07	10,143	16,154	16.151	18,421	20.443				16,115
/fil	2.381	2 250	2000	2.350	2.350	2.350	2,350	2,351	2,355	2,382	2.367	2373			2,382	2,386	2,390	2 394			}	2,405
\ [T]d	0.154	0.467	0.137	0,158	0.149	0.153	0.153	0.152	0.154	0.158	0.152	0.154	27.7	0,155	0,153	0.152	0.152			0.152		0.162
PIHI	0.975	0100	AUC/D	0,378	0:382	0.375	0,376	0.385	0.381	0 399	0.378	7920	7000	0 381	0,393	0.378	0.384	88610	0000	0.373	7.00377	0.379
Win	14 02A	1.00	14,931	14,949	14,952	14.942	15.487	18 131	18 147	18.159	1			16.145	16.154		ľ			25,080	19.705	18 115
Ve.	0000	0.780	0.790	0.790	0.780	0.790	0 790	2007	791	0.703	707.0	0.70	0./85	0.798	797 0	0.708	0.7.00	0.780	0.800	0,801	0.802	O AO3
	0700	3.840	3.948	3.948	3.948	3 948	2 048	2,040	2.000	2,633	2000	3.808	3.8/5	3.981	2 088	1000	3,881	OAR'S	4.000	4.004	4.009	1 045
no faor We	2001 0111	123	143	183	183	200	222	676	200	202	3	303	323	343	202	38	3	404	424	444	484	797

30 cm Cartrol Vc = 4.221 Win - 16.123

Page 1



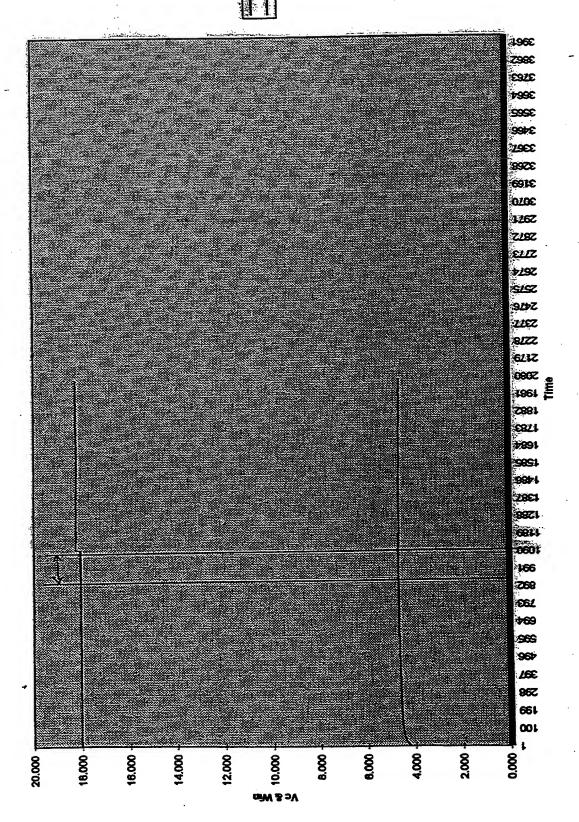
Sage 1

4	
1	



		M	PIHI	PILI 0.154	VfII 2 587	Win 18.129	Vc 4.222	Statistics from Points 905 - 1100 (0.505 iii.g.	Average Std Dev	Std Dev
4.222	0.843	10.128	A04.0		2.588		4.222	Λς	4.683	
4.222	0,040		0.418		2.588		4.224	Win	18.041	0.007
4 233	0.847	L	0,435	0.151	2.598	18.040				
4.245		18.045	0,437		2.805		4,245			
4.258	0.851	18.038	0(388		١		4.256			
4.285	0.863	18.031	0,417			1	4.285			
4.274	0.855	18.022	0,415				۱			
4.281	0.858	18,028	0,420							
4.288	0.858	18,038								
4.295	0.859	18,038	0,409							
4.301	0.880	18.023								
4.308	0.882	18,019								
4.314	0,883	18,025	0,418			`				
4.319	0.884	18.033	0,405	0.148						
4.326	0.885	18.039	0 423							
186 V	O ARR	18.041	0,408	0.148	2.679	18,041	4,331			

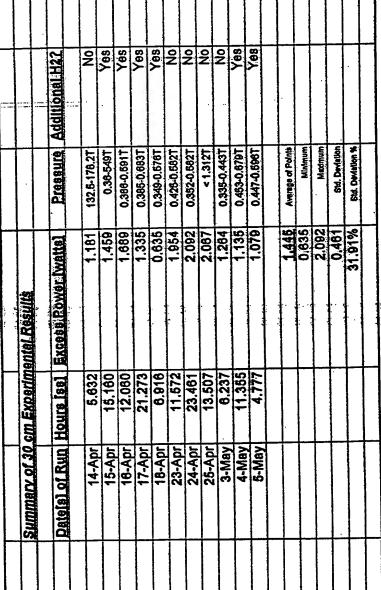
30 cm Control Ve = 4.663 Win = 18.041 April 30, 1997 18 watt point

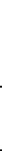


age 1









Summary of Exc. Power Produced





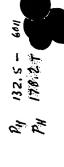
	_				A		,			- 1	Te. ye.	<u> </u>						- 7	- 1			- ,	7	3.	· 3
	Max	4,294	15.268							***************************************	445						-								Sand to have a second
	_	4,240	14,970	4																			į		-
Statistics for 6011 - 8033[5.632 hrs	Std Dev	0,015	0.081																						T
or 6011 - 80	Average	4.288	15.141																						
Statistics f		Vc	MIN													٠					, , , , , , , , , , , , , , , , , , , ,				
	0000	0.000	0,000	0000	0000	000'0	0.000	0,000	0000	0.004	0.041	0,087	0.133	0.177	0.219	0,258	0,295	0.331	0.385	0,398	0,430	0,461	0,491	0.521	0.550
Win	0.874	2.634	0.150	0,070	0,088	1,083	11.892	14.905	15.142	15,018	14.941	14.970	14,995	14.998	14,987	14,991	14,992	14,993	15,007	15,003	15.003	15:002	15,012	15.007	14,998
Vf I	900'0	0,000	0.000	0,000	0,000	000.0	0.000	0.000	0.000	000'0	0,000	000'0	0,000	000'0	0,000	0000	0000	0000	0000	000'0	0.000	0,000			0000
	0,125	0.128	0.124	0.125	0.128	0.125	0.125	0.128	0.124	0.115	0.127		0.125	0.123	0.124	0,122		0,128	0,122	0,124	0.122	0.125	747	0.122	0.124
HJd		0.997	1.035	1.037	1.020	1.045		1.085	1.287		1.568		1,739	1,849	1,899	1,944	_	3 2015				2,166			3 2,244
Win	0,874	2.634	0.150	0,070	0.088	1,083	11.892	14,905	15.142	15,018	14.94	14.970	14,995	14,998	14.987	14,991	14,992	14,993	15,007	15,003	15,003	15,002	15,012	15,007	14,998
Vc.	0.000	0.000	0.000	0.000	0000	0.000	0.000	0000	0.000	0.001	0.008	0.017	0,027	0.035	0.044	0.052	0,059		0.073	0.080	0.088	0.092	0.098	_	0.110
Vc	0,000	0.00	0.000	0.000	0.000	0.000	0,000	0.000	0,000	0.004	0.041	0.087	0.133	0.177	0.219	0.258	0.295	0.331	0.365	0,398	0,430	0.481	0.491	0.521	0.580
Time [sec]	88	86	108	116	128	137	148	158	187	177	187	197	207	217	227	237	247	257	267	277	287	297	307	317	327

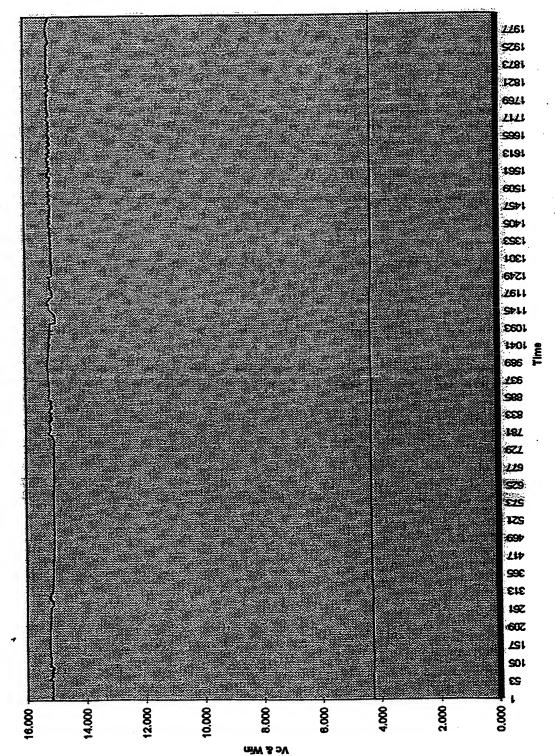




	Single-1-1-1				
Win	Predicted Vc				
14.5		Given Vc=	4.268		
15.0		Estimated			
15:5		Watts Out	16.322	watts of power	
16:0		Actual =	15.141	watts of input power	
16.5			1.181	excess watts	
17.0					
17.5					
18:0					
18.5	4.768				
					-
					<u> </u>

April 14, 1997 - 16 watt warmup









							:		مزدد		<u></u>						ایرانمه	<u>:</u>			_
	Max	A 280	2000	15,289		N ON I	247.51											Taraba cara			4
	Min	600	4,400	14.954		1,75	200														
Statistics for 2 - 6445 [15.16Unrs	Std Dev	ic	0,023	0.083																	
or 2 - 6446	Average	٦.	4.331	15.137			12.4														
Statistics f			Λc	MIM			7														,
رد ح	1 200	4.604	4,292	COC Y	7,605	4.291	4.291	4.291	4 290		4.290	4.290	7 200	4,480	4.290	4.290	4.290	4.290	000	4.280	4,290
Win	010 21	747'01	15.244	46.930	10.400	15,248	15,251	15,258		١	15.258	15.284	T		15.255	15,285	15.248	15 251			16.252
<i>\</i>	44.0	000'7	2.648	0100	6:040	2:645	2,645	2,645			2.045	2.845	1	2.645	2.844	2.845	2.845		1		2.644
MIL.	•	98.876	96,976	ŧ.	_1	99:978	926'66	979.99	₽.	ŧ	98,978	00 078	1	01 99,978	96,976	0 99.976	4.	E	- 2	. 4	0 99:978
- LUI		15,242 243.980	15 244 243 980		244,	5.248 244.000	5.251 244.040	A 244 030		**	6 244.070	776		57 244 / 110	16.256 244,130		PPC		3	5,250 244,270	52 244 310
144112		_			15,239					10,249	15.258	1 4 5 A A		16.257	ľ						
	2	0.859	0 850	_	· 0.859	0.859	0 859	┸	1	0.828	0.859	030 0		0.859	0 850		1		0.858	0.829	O ARO
		4.292	A 202	4.606	4.292	4.291	A 201	700	4.201	4.280	4 290	000	4.480	4.290	A 200	1 200	2000	4.290	4.290	4.290	A SOA
	me seci vc	82	18	70	102	112	422	7007	132	142	183	200	701	172	482	102	781	707	212	223	222





		10 10 5mm			A CANADA
 Win	Predicted Vc				3
 14.5		Given Vc=	4.331		4
 15.0		Estimated			
 15.5		Watts Out		watts of power	
 16.0		Actual =		watts of input power	
 16.5			1.459	excess watts	
 17.0		`			
 17.5	·				
 18.0					
 18.5					
 1					
 					
 +	i				
 +					
 	 				





						. <u></u>	<u></u>	_	_	_			.55	<u></u>		4			_	<u>, :</u> चि			1
2.4.2.2	YRM	5.135	18:283		A C S C S C S C S C S C S C S C S C S C	1						Secondary area			-		•						
nrsi	MIN	5,040	18.058	2220	ĺ	0382										3							
_	8td D8V	0.027			-	0.029							·					<u> </u>					
or 4192-85	Average	5.078	977.97	10,140		0.486															_		
Statistics 1	:	3		MiM		[H]d																	7
Vc	956 A		4,000	4,339	4.339	4,339	956 A				4.338	BEE P			4.338	4.339				4.351	4.250		
Win	4E 47R	25.7.2	13,1/B	15.184	15.178	15,173	18 180		15.1/0	15,199	15.198	4R 40R	7	15.200	15,540	47 460	1000		18.145	18.136			10,080
\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	2 804	1	-	2.679	2.879	_		١	7	2.679	2.678		l	3.679	2.879	5 A 70			2,683	2.689	1	١	3 2,(04
1119	7 1 4	Ī	5 0.154	0.158	3 0.155		1	1		0.153	0.150	L	1	5 0.133	R 0 133	L		-	8 0.138	C61 0 182	1	1	7 0.133
Fig	ľ	2	9 0.445	0	6	۲	ľ		0	9 0.448	C		15 0.400	_		Ϊ		37 0.548	15 0,558	ACA C		_	93 0.617
Win		15,1/6	15.179	15.184				15,180	15.178	15,199	ľ		15.195	15.200				18.087	18,145				4 18,093
17/1	1	5 0.868	5 0,868	5 0 868		1	1	4 0.868	4 0.888	A O ABB			4 0.868	4 0 888	1	4	4 0.868	998'0 9	0 889	1	1		4 0.874
1	- 1	4.335	4.335	7 336	1.995			4.334	4.334	A 23.4			4.334	786 7			4.334	4.336				4,355	4.364
	1M8 880	125	135	446	2 4	CC	165	175	185	108	200	202	215	206	677	235	248	255	JAC	707	275	285	295





	Security A	. The state of the			1.21	in the likely	and the second
							(). ().
Win	Predicted	Vc	Sa	;			
14:5			Given Vc=	5.075			
15.0			Estimated				·.·
15.5			Watts Out	19.835	watts of power	1	
16.0			Actual =		watts of input po	ower	·
16.5	4.309			1.689	excess watts		
17.0							
17.5			·			1	
18.0	4.653						'
18.5	4.768						
			ì				





		-				_		_	_::	200		٠.,			_	_			-	14.		_	Ė	7	
1	Max	5.05		18:320		0000	Olono		K. 1					***************************************			Contract of the Contract of th			A contraction					
1		A RRA	1 XX	17.755		-	0:385		1					-		+		3. · · · · · · · · · · · · · · · · · · ·					-		
21	Std Dev Min	ANG	2000	0.081	1		0.035	i																-	
2 - 7640	Average 81	1001	1881	18 135	2	-	0.492		-							+									
Statistics for Z - 7640	A	-) (Min			EHJ										_								
	S OFO	2000	5.049	6 050	0000	5.049	6,049	6 040	3.048	5.048	5.049	0000	0000	5.050	400	2,030	6.050	R 080	2012	5,050	R.050	2000	000'0	5,050	
<u>ح</u>	40 444	10.	18,139	07.7 07	18,143	18,139	18.147	737 67	16,151	18.149	18.153		18,150	18.150	1	18.153	18.153	40 4 40	10,170	18.148	CVF 81	1000	18,140	18,151	
M	- 4	3.302	3.295	100	3.294	3,294	2 294		3.294	3,294	3 294		3,294	706 8		3,295	3,295	1	1	3,295	9 20E	1		3,295	1
	,	0.147	0.155	1	0:160	0.152	0 148	1	0.158	0.146	0 15B	2	0.150	0 158	"	0.149	0 452		0,107	155	97.7	7	9 0,158	3 0.148	
MINIS INT.	4	0.526	5 A 47	1	3 0.487	0 614		2	1 0.481	0.643		1	0.518	1	⅃	3 0,632	L	1	9 0.49	8 0 481	ŀ	1	5 0,489		
NIK.		18,141	10 120		18.143	18 130			18.151	18 149			18,150			18.153	l		18.149	18.148			18.145	18.18.	2
1000	VG	1.010	4 040	-	1.010	4 040	1	1.010	1.010	1 010		U10.1	1 010	1	1.010	1.010	1	7	1.010	1 010		9 1.010	9 1.010	4 040	
	۸c	4.989	1000	4'99	4.999	000 7	4.00	4.888	4.999	7 000		4.999	000 P		4.888	A GOD			4.999			4.999	4.999	7 000	
1.	[986]	78	3	8	98	100	92	116	128	424	001	148	458	3	166	17R	2	186	198	anc	200	216	228	900	





odinis.						
Alle			.4			
Win	Predicted Vc	2010 500 000 000 000 000 000 000 000 000				
14.5	3:849	Given Vc=	4.991			_ }
15.0	3:964	Estimated	*0770			
15.5	4:079	Watts Out	19:4/UW	atts of power		ì
16.0	4.194	Actual =		atts of input p	ower	
16.5	4.309		1.335 e	ccess watts		
17.0			4			
17.5						
18.0			<u>.</u>			Ş
18.5	4.768					į
			ì			
						्
						. 9
				<u> </u>		
			111		:*	

4	



		<u>ئىي</u> .	محظ							-	.: .		_		· ;	3.1	4.	7
	ğ	4.816	18,105						77. 17. 17. 17. 17. 17. 17. 17. 17. 17.						1			
(C.916 hr)	Min	4.778	17.868	0760	0,040		***************************************									-		
- 1	Std Dev	0.009	0.048	700	Oco;o													
or 2-2485	Average	4.791	17 984	700	0.404													
Statistics for		ΛC	S S		PIT													
Ve	4.801	4.801	A ROT	2012	4,801	4,802	4.802	4.802	4,802	4,802	4.801	4,801	4,800			4.799	4.798	4.798
WIN	17.938	17,939	47 07R	210.11	17,961	17.952	17.931	17.911	17.895	17.895	17,900	17,908	17,899	17,910	17.907			17.931
×	3.093	3.088		-		3.086	3,086	3,086	3.086	3,086	3.085	3.085	3.084	3.084	3.084	3,084		3,082
I TIG	0.132	1	1	1	0.135	0.131	0,131	0.133	5 0.128	9 0.132	9 0.130	9 0.130	2 0.131	0,129	1 0.132	6 0.130	0 0.132	2 0.130
HIG		┸	1		0.501	0.508	0.810	0.480		乚	L	L	辶	_	7 0.491	0 0 508	1 0.500	1 0,602
Win	17 938	47 030	0011	17.975	17.981	17.952	17.93	17.91	17.895	17.895	17,900	17.908	17,899	17,910	17.807	17,910	17.92	17.931
Vc.	0 981	0.084	100.0	0.981	0.981	0.981	0.961	0.981		0.981	0.961	0.981	L	0.981	0.981	0.981	0.980	0.980
چ چ	4 801	1,00	100.	4.801	4.801	4.802	4,802	4.802	4.802	4.802	4.801	4.801	4.800	4.800	4.799	4.789	4.798	4.798
We faeci W	100	20	S	75	85	95	105	115	125	135	145	185	185	175	188	195	205	216





		a dillai i i i				
			1			
	Win	Predicted Vc		,		
	14.5		Given Vc=	4.791		
	15.0		Estimated		Sales	
	15.5		Watts Out	18.599	watts of power	
	16.0		Actual =	17.964	watts of input power	
	16.5			0.635	excess watts	
	17.0					
	17.5					1
	18.0					
	18.5					
	 					
	 	i .				<u> </u>
					· · · · · · · · · · · · · · · · · · ·	
	1					





	ľ	١		Γ	l	1166	Win	3	Statis	lics fo	r 2437 - 4	Statistics for 2437 - 4515 [11.572 hrs]	2 hrs]	
		Vc.	WIN	FIG	PIE	5			000	4	000000	Std Day	Min	Max
0.00	0	0.000	0.084	0.507	0.138				0.000		Average	010 Day	1 240	
000	ᇹ	0000	0.083	0.508	0.137	0.000	0.083		0.000	2	4.431	0.040	ľ	
3	de	0000	0.070		0.138	0.000	0.070		0.000	Win	15.078	0.015		
0000	de	0000	0.062	0.530	i i	0.000	0.082		0.000	툅	0.508	0.021	0.425	0.582
0000	0	0.00	0.089	0.531		0.000	0.089		0.000					
0.00	le	0.000	0.081	0.531	0.146	0.000	0.081		0.000					
000	le	0000	0.070	0.522	0.278	0.000	0.070		0.000					
0000	de	0.000	0.088	P	0.287	0.000	0.088		0.000	1				
	000	0000	8.831	0.523	0.292	0.000	8.831		0.000	1				
įįč	000	0.00	15.024	0.577	0.351	0.000	15.024		0.000	1				
	000	0000		0,653	0.485	0.000	15.088		0.000					
0 015	2	0.003		0.708	0.583	0.000			0.015					
	0 098	0.019	14.910	0.741	0.595	0.000	14.910		0.098	1				
-	0 177	0.035	14.940	0.750	0.610	0.000	14.940		0.177					
: 0	0 250	0.050	14.969	0.755	0.820	0.000	14.969		0.250					
(0	0.317	0.083	14.992	0.842	0.841	0.000	14.992		0.317					
la.	0.381	0.078	15.029	0.767	0.834	0.000	15.029		0.381	٦				
1	1		l											





 Win	Predicted	Vc				<u> </u>
14.5	3.849		Given Vc≃	4.431		
 15.0	3.964		Estimated		<u> </u>	
15.5	4.079		Watts Out		watts of power	
16.0			Actual =		watts of input power	·
 16.5				1.954	excess watts	
17.0						
 17.5	4.539					<u> </u>
 18.0	4.653					
 18.5	4.768					
						
						
						-
	1					
					i i	·





Ime [sec] Vc Vc Vin PLJ PLJ PLJ 58 4.470 0.894 15.094 0.508 0.132 78 4.470 0.894 15.094 0.508 0.132 98 4.470 0.894 15.081 0.509 0.133 118 4.471 0.894 15.081 0.552 0.131 158 4.471 0.894 15.077 0.552 0.136 178 4.471 0.894 15.075 0.526 0.136 189 4.471 0.894 15.078 0.539 0.137 218 4.471 0.894 15.077 0.526 0.136 228 4.471 0.894 15.077 0.526 0.136 279 4.471 0.894 15.077 0.526 0.136 279 4.471 0.894 15.080 0.518 0.134 299 4.471 0.894 15.086 0.529 0.131 2	2.801 2.801 2.801 2.801 2.801 2.801 2.801	4.470 4.470 4.471 4.471 4.471 4.471	Average Std Dev Min Vc 4.457 0.012 4 Win 15.053 0.035 14 P[H] 0.459 0.038 0	57 0.012 53 0.035 59 0.038	1.440	Max 4.484 15.114 0.582
0.894 15.081 0.500 0.134 0.894 15.084 0.508 0.132 0.894 15.083 0.508 0.133 0.894 15.081 0.527 0.131 0.894 15.082 0.526 0.136 0.894 15.075 0.513 0.134 0.894 15.075 0.539 0.137 0.894 15.077 0.526 0.136 0.894 15.077 0.526 0.136 0.894 15.077 0.526 0.136 0.894 15.077 0.526 0.136 0.894 15.077 0.526 0.136 0.894 15.080 0.518 0.136 0.894 15.085 0.521 0.136 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136				0.038	4.440	15.114
0.894 15.084 0.508 0.132 0.894 15.083 0.509 0.133 0.894 15.081 0.527 0.131 0.894 15.077 0.552 0.136 0.894 15.075 0.513 0.134 0.894 15.078 0.539 0.137 0.894 15.077 0.503 0.136 0.894 15.077 0.526 0.136 0.894 15.077 0.526 0.136 0.894 15.077 0.526 0.136 0.894 15.077 0.526 0.136 0.894 15.080 0.518 0.136 0.894 15.080 0.518 0.136 0.894 15.085 0.492 0.131 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136						0.582
0.894 15.083 0.509 0.133 0.894 15.081 0.527 0.131 0.894 15.082 0.526 0.136 0.894 15.075 0.513 0.134 0.894 15.078 0.539 0.137 0.894 15.078 0.539 0.137 0.894 15.077 0.526 0.136 0.894 15.077 0.526 0.136 0.894 15.077 0.528 0.136 0.894 15.077 0.508 0.136 0.894 15.076 0.528 0.136 0.894 15.077 0.508 0.136 0.894 15.085 0.518 0.136 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136						0.582
0.894 15.081 0.527 0.131 0.894 15.082 0.526 0.136 0.894 15.082 0.526 0.136 0.894 15.075 0.513 0.134 0.894 15.078 0.539 0.137 0.894 15.073 0.503 0.130 0.894 15.077 0.528 0.136 0.894 15.071 0.508 0.136 0.894 15.080 0.518 0.136 0.894 15.085 0.500 0.131 0.894 15.085 0.521 0.136 0.894 15.085 0.521 0.136 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136					0.352	0.582
0.894 15.077 0.552 0.137 0.894 15.075 0.526 0.136 0.894 15.075 0.539 0.134 0.894 15.078 0.539 0.137 0.894 15.077 0.528 0.136 0.894 15.077 0.528 0.136 0.894 15.071 0.508 0.136 0.894 15.080 0.518 0.136 0.894 15.080 0.518 0.136 0.894 15.085 0.492 0.131 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136						
0.894 15.082 0.526 0.136 0.894 15.075 0.513 0.134 0.894 15.078 0.539 0.137 0.894 15.077 0.526 0.136 0.894 15.077 0.528 0.136 0.894 15.071 0.508 0.134 0.894 15.080 0.518 0.136 0.894 15.086 0.518 0.136 0.894 15.086 0.518 0.131 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136						
0.894 15.075 0.513 0.134 0.894 15.078 0.539 0.137 0.894 15.077 0.526 0.136 0.894 15.077 0.528 0.134 0.894 15.071 0.508 0.134 0.894 15.080 0.518 0.136 0.894 15.085 0.492 0.131 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136 0.894 15.086 0.521 0.136 0.894 15.086 0.520 0.131						
0.894 15.078 0.539 0.894 15.073 0.503 0.894 15.077 0.528 0.894 15.080 0.518 0.894 15.085 0.482 0.894 15.085 0.521 0.894 15.085 0.521 0.894 15.086 0.521 0.894 15.089 0.521						
0.894 15.073 0.503 0.894 15.077 0.528 0.894 15.071 0.508 0.894 15.080 0.518 0.894 15.085 0.492 0.894 15.086 0.521 0.894 15.086 0.521 0.894 15.078 0.500						
0.894 15.077 0.526 0.894 15.071 0.508 0.894 15.060 0.518 0.894 15.085 0.492 0.894 15.086 0.521 0.894 15.078 0.500						
0.894 15.071 0.508 0.894 15.060 0.518 0.894 15.065 0.482 0.894 15.088 0.521 0.894 15.078 0.500	2.801 15.077					
0.894 15.060 0.518 0.894 15.085 0.492 0.894 15.086 0.521 0.894 15.078 0.500						
0.894 15.085 0.492 0.894 15.086 0.521 0.894 15.078 0.500						
0.894 15.088 0.521 0.894 15.078 0.500	2.802 15.085					
0.894 15.078 0.500	2.802 15.066					
0.895 15.079 0.509						
4.472 0.895 15.088 0.507 0.134	2.802 15.086	86 4.472				





Win	Predicted Vc				4
14.5	3.849	Given Vc=	4.457		
15.0		Estimated			
15.5		Watts Out		watts of power	
16.0		Actual =	15.053	watts of input power	
16.5			2.092	excess watts	
17.0					
17.5					
18.0					
18.5					
				<u> </u>	
	 				- 1



K		



205 275 275 251 1103 1103 551	2.790 15.005 2.790 15.005 2.759 14.998 2.759 15.015 2.759 15.042 2.759 15.041			Average	Std Dev	Min	Max
275 348 017 110 110 122							
348 051 017 110 110 122 551			ΛC	4.442		Ì	
051 152 103 110 122 551		Ĺ	Win	15.013			
152 1103 1103 110 122 551		4.445	[H]d	0.448	0.374	0.000	1.312
152 110 122 551		5 4.445		pressure d	pressure data is erratic		
<u> </u>		2 4.445					
		4.445					
	2.783 15.055	5 4.444					
	2.791 15.093						
900	2.783 15.097	7 4.444					
0.005 0.182	2.771 15.075	5 4.443					
0.005 0.145	2,776 15.089	9 4.443					
0.008 0.145	2.778 15.087	7 4.444					
0.325 0.043	2,795 15,038	8 4.444					
15.018 1.175 0.080	2.788 15.018						
0.403 0.239	2.761						
15.000 0.014 0.212	2.788 15.000	0 4.445					

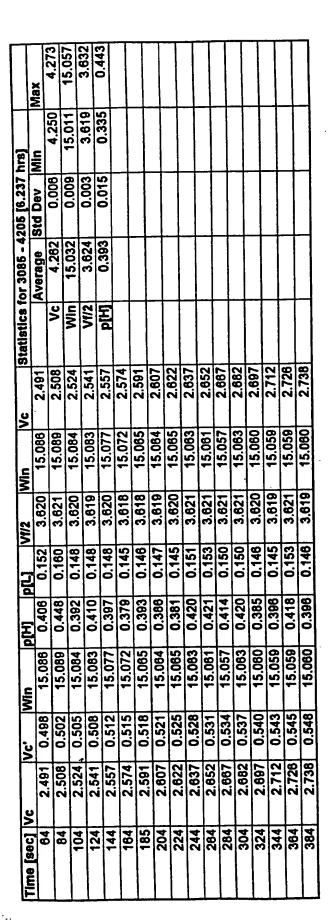




 	<u> </u>		T				T
 Win	Predicted	Vc					
 14.5			Given Vc=	4.442			
 15.0			Estimated				
 15.5			Watts Out		watts of po		
 16.0			Actual =		watts of in		·
 16.5				2.067	excess wa	itts	
17.0							
 17.5							
 18.0	4.653						
 18.5	4.768						
 					L		
 							
 							
 						<u></u>	
							<u> </u>
 							
 					<u> </u>	<u> </u>	<u> </u>







.

Ogna d





 						
 Win	Predicted	<u>Vc</u>				
 14.5	3.849		Given Vc≃	4.262		
 15.0	3.964		Estimated			
15.5	4.079		Watts Out		watts of power	
 16.0	4.194		Actual =		watts of input power	
 16.5	4.309			1.264	excess watts	
 17.0						4
17.5	4.539					
 18.0	4.653					
18.5	4.768					
						<u> </u>
						<u> </u>
						<u> </u>





Т	-	6	T÷	-10	اھ	का	1	Т	Т	\top	T	٦		_	Τ	Т	1	Т	٦
	Max	4.219	4 A 084	4.90	0.678	3.544													
hrs	Min	4.188	44 000	14.000	0.453	3.518													
89 (11.355	Std Dev	9000	6,6	0.013	0.029	0.00									*				
r 1712 - 67	Average 8	4 200		14.891	0.578	3.525													
Statistics for 1712 - 5789 [11.355 hrs		3	2	Win	p[H]d	Vf/2													
Vc	4 310	1 242	4.312	4.313	4.314	4.315	4.315	4.315	4.315	4.314	4.314	4.315	4 315	1 245	4.010	4.315	4.315	4.314	4.314
Win	15.090	45.000	13.080	15.089	15.090	15.094	15.089	15.094	15.095	15.095	15,113	15.109	15 443	2 7 7	13.112	15.108	15.111	15.118	15.114
Vf/2	940		3.020	3.618	3.619	3.619	3.619	3.819	3.619	3.618	3.619	3.619	2 840		\bot		3.620	3.619	3.619
nfi 1	0.263		0.256	0.259	0.255	1	0.258	0.287	0.255	0.258	0.289	0.287	1.		-	0.270	0.273	0.272	0.273
25	0.520	ا د	0.353	0.370	0.399	0	0	0	°	0.374	0.388	0.380	1	اد		0.389	0.392	3 0.392	0.382
Wile	75.000	13.080	15.096	15.089	15.090	15 094	15.089	15.094	15,095	15.095	15,113	15 109		15,113	15.112	15.108	15.111	15.118	15,114
1	3	┙	0.862	• 0.883	O 883	1	1	L		L	┸	L		0.863	0.863	6.883	0.883	<u>L</u>	0 883
	-1	4.310	4.312	4.313	A 21A	4.017	A 315	4 345	4.315	4 314	A 314	A 245	7.0.4	4.315	4.315	4.315	4.315	4.314	A 314
	a last am	47	53	6	3 5	2 6	3 8	3 6	113	123	193	3 5	2	153	163	173	183	103	200





						<u> </u>
 Win	Predicted '	<u>Vc</u>				<u> </u>
 14.5			Given Vc=	4.200		
 15.0			Estimated		<u></u>	
 15.5	4.079		Watts Out		watts of power	<u> </u>
 16.0		<u>.</u>	Actual =		watts of input power	
 16.5				1,135	excess watts	
17.0						
17.5						
 18.0						ļ
 18.5	4.768					
						<u> </u>
						<u> </u>
 						1





一	\neg	ह्रा	<u></u>	37	<u>@</u>	Т	Т	Т	\top	Т	\neg	П	Т	T	Т	T	٦
	Max		15.004		0.598												
7 hvs)	Min	4.175	14.857	3.505	0.447												
17 (4:77	Std Dev	0.005	0.028	0.003	0.024												
Statistics for 2 - 847 (4:777 hrs	Average	4.187	14.891	3.522	0.538												
Statistics		Λc	Win	Vf/2	GH)	,											
Vc	4.190	4.189	4.189	4.188	4.188	4.188		4.189	4.189	4.190	4.190	4.191	4.192	4.192	4.193	4.194	4.195
Win	14.879	14.878	14.877	14.872	14.876	14.883	14.881	14.888	14.895	14.897		14,885		14.901	14.907	14.908	14.902
V6/2	3.528	1	3.528	l_	3.527	3.527	3.527	3.528	3.529	3.530	3.530	3.530	3.531	3.531	3.532	3.534	3,533
loft.1	0.136	1	<u> </u>	1	0.141	0.142	0.144	0.134	0.142	0.139	0.140	0.139		0.142	0.141	0.141	0.139
Ho		Ö		0	0	0.592	0.598		_	0.550	_	0.552	0.587	0.581	0.583	0.558	0.569
Win	14.879	14.878	14 877	14.872	14.876	14.883	14.881	14.888	14.895	14.897	14.892	14.885	14.886	14.901	14.907	14.908	14.902
Vc.	0.838	1		ـــــــــــــــــــــــــــــــــــــــ	1	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.839	0.839	0.839
Ve	4 190	4 189	A 180	4.188	4.188	4.188	4.188	4.189	4.189	4.190	4.190	4.191	4.192	4.192	4.193	4.194	4.195
Por I	28	78	8	118	138	158	177	197	217	237	257	277	297	317	337	357	377
ma faari																	





Win	Predicted				
14	5 3.849				
15	0 3.964	Estima			
15	5 4.079	Watts (watts of power	
16	.0 4.194	Actual		watts of input powe	r
16	.5 4.309		1.079	excess watts	
17	.0 4.424				
17	.5 4.539				
18	.0 4.653				
18	.5 4.768				
				1	



THESIS APPENDIX NINE

the second second second

.

d againered usernands

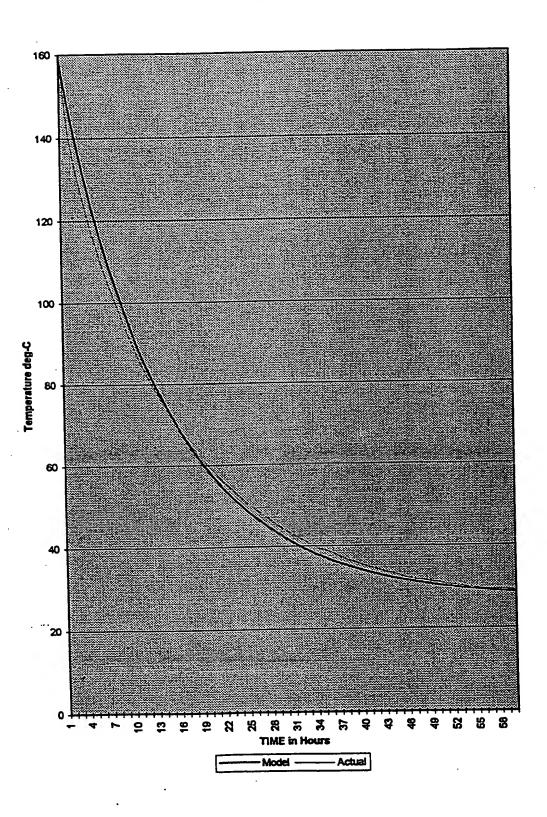
P\$5.000.0





THIS PAGE BLANK (USPTO)

Model vs. Actual Data



Page 1





THIS PAGE BLANK (USPTO)





Heat Loss Model for HPC Test 15,9 -	HPC Test 1	HPC Test 1	- 6'9	Max	- May 3-4, 1996	¥(c=	40850	=NO	0.85	
Heat Loss Predictions	280	280	Heat Loss P	0	rediction		HE I			T
T - 6	Delta - T	Delta - T	Next Per. Be	8	ısı	/s.	Епог	Temp.		
Predicted	Predicted	Predicted	Predicted Pri	٥	lction	Actuel		Fror - C		
268.1	268.1	268.1	268.1	$ \bot $						#VALUE!
27.1 240.9	27.1 240.9	240.9		_1_			%000		Unable to Replicate	
240.8	27.1 240.8	240.8					0000		Precipitous Drop In	
27.1	27.1 238.5	238.5					0.00%		Internal Temperature	6
27.1 220.8	27.1 220.8	220.8		_	248.0 218.3 Start Mode		0.00%			
101.6	101.6	472.4		-	218.1		9.30%			
159.9	27.4 159.9	159.9		_	217.8		16.48%			
27.1 151.8	27.1 151.8	151.8		_	217.8		21.62%			
27.1	27.1 148.2	148.2					25.42%			
480.51 27.1 142.1	27.1 142.1	142.1					28.32%			
400 E 27 1 139.4	27 1 139.4	139.4					30.25%			
1371	27 4 137 1	137.1			216.6		31.93%			
462 6 27 1 135.5	27.1 135.5	135.5		1			33.09%			
484 5 27 1 134.4	27.1 134.4	134.4			218.2		33.85%			
133.4	27.1 133.4	133.4					34.53%	4.CC		
159.7 27.1 132.6	27.1 132.6	132.6				215.7	35.00%			
158.8 27.1	27.1 131.7	131.7				158.4				
158.4 27.1 131.3	27.1 131.3	131.3	\perp					9.0		
157.6 27.1 130.3	430.5	130.3		1 6		157.2				
129.5	27.1 129.5	129.5							-	
158.4 27.1 129.3	27.1 129.3	129.3								
158.2 27.1	27.1 129.1	129.1								
155.5	27.1 128.4	128.4		,, -					1	
155.3	27.1 128.2	128.2			5 157.5					
27.1	27.1 127.7	127.7			٠			2.5	0.6	
454 A 27.1	27.1 127.5	127.5		٠. ١						
27.1	27.1 127.1	127.1		1						
153 8 27.1 128.7	27.1 128.7	128.7		156.8						
27.1	27.1 128.6	128.8		انعا	7 158.7	7 153.7	1.94%	3.0		







3.3	3.6	3.7	3.8	4.0	3.8	4.1	4.1	4.3	4.3	4.4	4.6	4.6	4.7	4.8	4.9	5.0	5.0	5.1	5.3	5.3	5.4	5.4	5.6	5.6	5.5	5.8	5.8	5.8	6.0	5.9	6.1		6.9	7.5	7.1	6.5
2.15%	2.33%		2.52%																				3.77%	3.81%	3.77%	3.95%	3.98%	3.95%	4.12%	4.02%	4.20%		4.86%	5.70%	5.71%	5.49%
153.2	152.8 2	152.5	152.2	151.9	151.9	151.5			150.8					149.5		149.0	148.8	148.5	148.2	148.0	147.8		147.3	147.1							145.5				·	118.0
158.5	158.41	156.2	156.0	155.9	155.7	155.6	155.4	155.2	155.1	154.9	154.8	154.6	154.4	154.3	154.1	154.0	153.8	153.6	153.5	153.3	153.2	153.0	152.9	152.7	152.5	152.4	152.2	152.1	151.9	151.8	151.8	Model A	148.4	139.8	131.5	124.0
156.5	156.4	158.2	158.0	155.9	155.7	155.6	155.4	155.2	155.1	154.9	154.8	154.6	154.4	154.3	154.1	154.0	153.8	153.6	153.5	153.3	153.2	153.0	152.9	152.7	152.5	152.4	152.2	152.1	151.9	151.8	151.8	151.8	148.3	139.3	131.2	123.7
128.1	125.7	125.4	125.1	124.8	124.8	124.4	124.2	123.8	123.7	123.4	123.1	122.9	122.8	122.4	122.1	121.9	121.7	121.4	121.1	120.9	120.7	120.5	120.2	120.0	119.9	119.5	119.3	119.2	118.8	118.8	118.4		114.5	105.2	97.6	
27.4	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.0	27.0	26.9		28.8
1522	452 B	152.5	152.2	151.9	151.9	151.5	151.3	150.9	150.8	150.5	150.2	150.0	149.7	149.5	149.2				148.2						ŀ								141.5		1	117.5
40075	4007.2	40108	40258	40318	40378	40438	40498	40556	40818	40677	40737	40797	40857	40917	40977	41038	44098	44158	41218	A1278	41338	41398	41459	41519	41578	41639	41699	41759	41819	41879	41040	CII 1 hr	-1	13	14	. 15





																														_		_		_	_	_	_	
											1																											
5.6	5.0	4.3	3.7	34	24	0		*: 0	8.0	0.3	-0.3	-0.4	-0.7	-0.9	-1.3	-1.5	-1.6	-1.9	-2.0	-1.9	-2.0	-2.0	-2.0	-1.9	-1.9	-1.9	-1.9	-1.8	-1.8	-1.9	-1.9	-1.7	-1.4	-1.5	-1.3	-1.3	-1.2	
5.07%	4 78%	%UE F	2 89%	2,00%	2,52,0	2.70%	2.32%	1./5%	1.11%	0.39%	-0.45%	-0.57%	-1.12%	-1.39%	-2.19%	-2.58%	-2.85%	-3.59%	-3.74%	-3.83%	-4.07%	-4.29%	-4.31%	-4.31%	-4.34%	-4.39%	-4.49%	-4.41%	-3.92%	-4.73%	-4.92%	-4.47%	-3.88%	-4.18%	-3.81%	-3.61%	-3.59%	
1110	105.0	0.00	0.00	0.08	80.0	0.78	82.0	79.0	75.0	72.0	0.69	98.0	64.0	62.0	90.0	58.0	58.0	54.0	52.0	50.0	49.0	0.87	48.5	45.0	43.0	42.0	410	40.0	40.0	39.0	38.5	38.0	37.0			35.0		
4400	10.0	110.4	104.4	98.8	93.6	88.8	. 84.3	80.2	76.3	72.8	89.5	88.4	83.8	808	58.5	582	54.1	52.2	200	0.00 A	17.4	787	42.5	4.0			20.00											
1.00	116./	110.2	104.2	98.6	93.4	88.6	84.1	80.0	78.2	728	S A	200.0	200.00	2.50	2000	4 8 4	200	2.4.5	32.1	200.0	40.0			44.5				28.0			30.6			33.6				33.1
		78.7	73.4	68.4	63.7	1	1		١		5 5		1	١			١					١		-					١		١					"		7.3
	26.7	28.7	10	1	1	١	1	1	- 1	- 1	١	-	1	- 1	- 1	l	- 1	- 1		Ė								27.0										
	111.3		100	1	1	١	1	- 1					l				ŀ				١	1	1	1	ł	1	1			39.6		38.4						
	18		- 4	2 9	900	07	21	22	. 23	24	25	28	27	28	29	30	31	32	33	34	35	38	37	38	39	40	41	42	43	44	45	48	47	48	49	90	55	25



Heat Loss Model - Vers 1.1

																-	_

-1.1	-1.2 ********	-0.8	-0.6	9.0-	-0.7	9.0-	-0.8	-0.5	-0.5	-0.4	-0.4	-0.3	-0.3	-0.3	-0.5	-0.5	0.5
-3.17%	-3.51%	-2.30%	-1.87%	-1.96%	-2.30%	-1.94%	-2.46%	-1.65%	-1.74%	-1.44%	-1.43%	-1.03%	-0.85%	-1.11%	-1.59%	-1.71%	-1.79%
33.01	33.0	32.0	32.0	32.0	31.0	31.0	31.0	31.0	30.0	30.0	30.0	30.0	29.0	29.0	29.0	28.0	29.0
328	32.2	31.8	31.5	31.2	30.9	30.6	30.3	30.1	29.9	29.7	29.5	29.3	29.1	29.0	28.8	28.7	28.6
22 A	32.2	31.8	31.5	31.2	30.9	30.8	30.3	30.1	29.9	29.7	29.5	29.3	29.1	29.0	28.8	28.7	28.8
A 7	8	5.00	5.4	4.8	4.8	4.2	4.1	3.6	3.4	3.1	2.9	2.8	2.4	2.3	2.3	2.2	2.1
27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0
7 00	35.7	20.4 A CC	22.0	34.8	31.8	31.2	31.1	30.8	30.4	30.4	20.00	20.00	200	203	20.00	20.00	20.4
	25	40 24	CC as	52	28.5	3 6	8	3 &	. 8	83 68	3 2	A S	3 8	87	8	8	25
			\perp											\perp			





THESIS- APPENDIX EIGHT





THIS PAGE BLANK (USPTO)





			_			2							-
			Max			7.405							
		hrs]	Min .			6.755							
0.00	200	3892 [8.053	Otal Day	old. Dav.		0.057							
Jordena 101	Statistics for Arianysis and	for 1000 - 3892 [8.053 hrs]	Assessed Oth Day Min	Average	1.453	7.084							
Dentination of	oldiisiica i				Vc	Win							
	<u>د</u>	1.274	7.07	1.2/4	1.274	1.271	1.268	1.274	1.274	1.274	1.274	1.274	1.274
		6.710		6.698	8.708	6.583	6.317	6.881	6.715		8.718	8.708	6.699
		0 134		0.134	0.134	0.131	0.128	0.134	0.134	0.134	0.134	0.134	0.134
	<u>×</u>	0 255	2031	0.255	0.255	0.252	0.247	0.255	0.255	0.255	0.255	0.255	0.255
	<u>ح</u>	4 274	1,61,7	1.274	1 274	1271	1.288	1 274	1 274	1 274	1 274	1 274	1274
	الالالالالالالالالالالالالالالالالالال	1	30	87	11	87	26	107	417	127	137	147	157



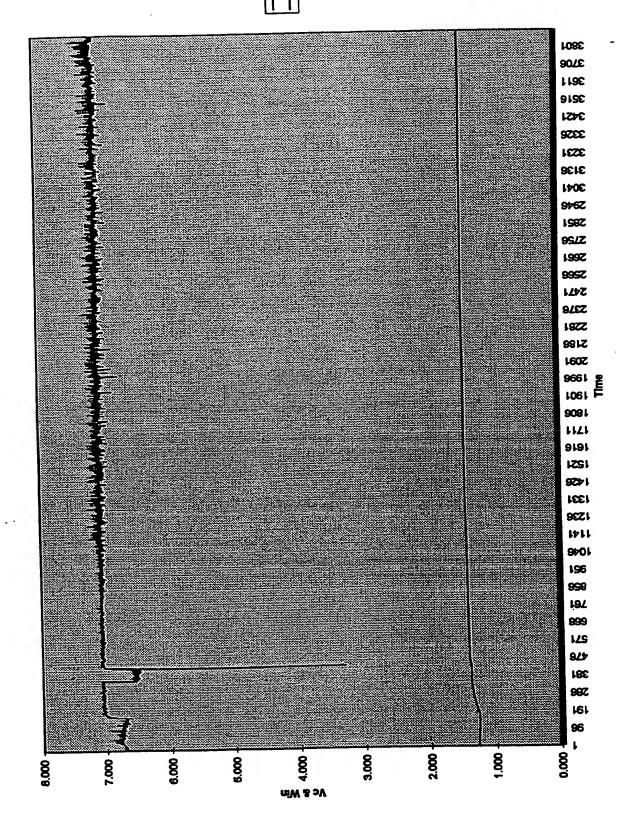


-		Vc.	×	Win	Vc	Statistics	Statistics for Analysis are	s are		
	1.274	0.255	0.134	6.710	1.274		for 2 - 389.	for 2 - 3892 [10.832 hrs]	ııs]	
1	1.274	0.255	0.134	869'9	1.274		Average	Average Std. Dev. Min	Min	Max
1	1.274	0.255	0.134	6.708	1.274	Vc	1.432			
1	1.271	0.252	0.131	6.563	1.271	Win	7.051	0.129	3.307	7.405
1	1.288		0.128	6.317	1.286					
1	1.274	L	0.134	6.681	1.274					
1	1.274		0.134	6.715	1.274					
1	1.274	0.255	0.134		1.274					
ı	1.274	0.255	0.134	6.716	1.274					



TP032797 Chart 1





Page 1





1	П	T	П	_	T	T	Т	T	Т	\neg		Т	\exists	\exists	
	-	-	_	1	1	1		1	1	1	1	1	1		
		Aax		7.250											
	181		1.464	7.009											
s are	for 2 - 16384 [45.175 hrs]	Average Std. Dev. Min	0.001	0.021											
Statistics for Analysis are	for 2 - 1638	Average		7.083											
Statistics (Vc	Win											
Vc	1.475	1.475	1.475	1.475	1.475	1,475	1.475	1.475	1.474	1.474	1.474	1.474	1.474	1.473	1.473
Win	7.112	7.208	7.131	7.150	7.140	7.188	7.078	7.093	7.118	7.088	7.089	7.115	7.084	7.088	7.081
	0.142	0.144	0.143	0.143	0.143	0.143	0.142	0.142	0.142	0.141	0.142	0.142	0.142	0.141	0.141
Vc.	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295
Vc	1.475	1.475	1.475	1,475	1.475	1.475	1.475	1.475	1.474	1.474	1.474	1.474	1.474	1.473	1.473
Time [sec]	47	57	87	11	87	26	107	117	127	137	147	157	187	177	187





																	+					
		_			54	-	22										+					
-				Max	1.454		CCO. /			+						-	+					
		hrel	1011	떨	1 445		5 6.958														-	
	sis are	84 F47 70B	101 7 - 0301 111.101	Average Std. Dev. Min	0000		0 0.015	ļ		-			+									
	Statistics for Analysis are		TOT & - 03	AVARAGE		VC 1.433	n 7.010	_												-		
	Statistics		5	2			.5 Win	ū	5	5	5		0	<u>15</u>	<u> </u>	2	15	15	15	9	2 :	ç
	ν	اء	7 1.445	4 445		5 1.445	1.445			1.445	1.445			1.445			1.445	1.445	1.445		ł	1.445
	Win		0 6.997			0 6.995	6.893	\downarrow	0 6.955	0 6.982	8 988		9 6.968	6.984			7.010	6.995				7.01
	,	×	0.140			9 0.140			0.140	0.140			9 0.139			0.14	9 0.140					o 14(
	1776	.oc	0 289	,	0.289	0 289			0.289	0 289			0.289	0 280		0.289	0.289				5 0.289	C ORC
		ر ک	1 445	21.	1.445	1 445	4 445	2	1.445	1 445		C++.	1.445			1.445					1.445	4 448
	ł	Lime [sec]	ă	3	75	AR	S	OA	105	448	201	C71	135	116	140	155	185	476	100	100	195	200

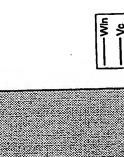


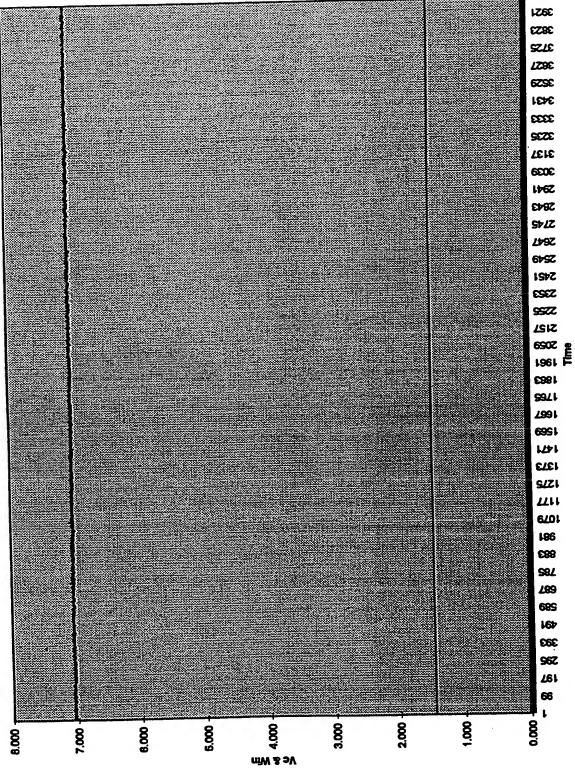


											-					1
		Jax	1.470	7.093				-								
	s]		1.460	7.004												
s are	for 2 - 8419 [23.438 hrs]	Average Std. Dev. Min	0.002	0.012												
Statistics for Analysis are	for 2 - 8419	Average	1.469	7.047												
Statistics f			Vc	Win												
۸c	1.481	1.481	1.481	1.461	1.461	1.461	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.461	1.461
Win	7.039	7.050	7.030	7.040	7.043	7.044	7.057	7.049	7.047	7.045	7.027	7.062	7.040	7.044	7.060	7.050
	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141
Vc.	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293
Vc	1.461	1.481	1 481	1.461	1.481	1.461	1.461	1.461	1.461	1.461	1.461	1.481	1.461	1.461	1.461	1.481
Time [sec]	34	44	24	64	74	84	95	104	114	124	134	144	154	164	174	184

TP033197 Chart 1







Page 1





1	7	7	7	\neg	\neg			7	_	7		7		\exists	\neg
		Max	1.472	7.267											
	rs]		1.457	6.985											
s are	6 [23.514 h	Average Std. Dev. Min	0.003	0.018											
Statistics for Analysis are	for 2 - 8446 [23.514 hrs]	Average		7.034											
Statistics			Λc	Win											
Vc	1.471	1.471	1.472	1.472	1.472	1.471	1.471	1.471	1.471	1.471	1.471	1.471	1.471	1.471	1.471
Win	7.027	7.018	7.019		7.017	7.043	7.037	7.025	7.039	7.018	7.020	7.035	7.039	7.037	7.043
×	0.141	0.140	0.140	0.141	0.140	0.141	0.141	0.140	0.141	0.140	0.140	0.141	0.141	0.141	0.141
Vc.	0.294	0.294	0.294	0.294	0.294	0.294	0.294	0.294	0.294	0.294	0.294	0.294	0.294	0.294	0.294
Vc	1.471	1.471	1.472	1.472	1.472	1.471	1.471	1.471	1.471	1.471	1.471	1.471	1.471	1.471	1.471
Time [sec]	-	61	71	81	91	101	111	121	132	141	151	161	172	182	192





	T	_				1	_									T	_		T			7	
_		_	+		2	2	74			-			1	_	_	-		+			$\frac{1}{1}$	_	
				Max	1	1.440	7 024	?															
		-				1.395	C09 9	0.052															
	are	roe 040 her	2010107	Noc Par		0.008	000	0.038							1								
	Statistics for Analysis are	3000	101 2 - 8386 [20:010 1115]	Assesso 18th Day Min	Average	1.440		6.852															
	Statistics for					۲۶	2	<u> </u>															
	7		1.438		1.438	4 428	254.	1.438		1.438	1 438		1.438	4 490	1.430	1.438		1.438	1 438	201:1	1.438	4 438	004.1
	1400		A 037		6.931	4000	0.831	8.942		6.966	A 052	١	6.940	١	0.830	A 020	2.0	6.932	A ORO	0.930	6.935	070	0.840
		>	0 130	3	0.139	60,0	0.138	0 130	3	0.139	0 4 30	0.138	0.139		0.138	428	201.5	0.139	067.0	0.138	0.139	6	O. 138
		× C	9900	0.500	0 288	200	0.288	0 288	207.	0.288	000	0.200	0.288		0.288	000	0.400	0.288	900	0.792	0 288		0.288
		<u>\ </u>	967	1.430	4 438	22	1.438	4 430	1.430	1.438	00,	1.438	1 438	3	1.438	007	1.430	1 438		1.438	1 438	3	1.438
		ma [sac] Vc	:	4	ž	10	62		5	84	3 3	85	403	104	112		122	432	301	142	452	361	182





		_	_	1		-	-	_				7	
							_						
			9	6	_								
		Max	1.446	7.079									
)	lin	1.410	8.708		•							
are	21.428 hrs	ld. Dev. A	9000	0.034									
r Analysis	for 2 - 7697 [21.428 hrs]	Average Std. Dev. Min	1.432	6.967									
Statistics for Analysis are	=	A	Λc	Win									
۸c	1.445	1.448	1.448	1.448	1.448	1.448	1.445	1.445	1.445	1.445	1.445	1.445	1.445
Win	6.973	6.961	6.958	6.975	6.971	6.980	6.972	6.953	6.974	6.974	6.955	6.975	6.963
<u>^</u>	0.139	0.139	0.139	0.140	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.140	0.139
Vc' ×	0.289	0.289	0.289	0.289	0.289	0.289	0.289	0.289	0.289	0.289	0.289	0.289	0.289
	1.445	1.448	1.446	1.446	1.448	1.446	1.445	1.445	1.445	1.445	1.445	1.445	1.445
ime [sec] Vc	38	48	58	88	78	88	86	108	118	128	138	148	158







3		101	Ŀ		Win	Λc	Statistics	Statistics for Analysis are	is are			
		1	4,	44,4		4 432	2	for 2 - 16384 [45,618 hrs]	84 [45.618	hrsl		
35	1.432	0.287	_	U. 138			1,5				1	
	1 432	0.287		0.139	6.843	3 1.432	32	Average	Sign		XRE	
FF	4 432	0 287	_	0.139	6.937	7 1.432	32 Vc	1.428				
85	1 432	0.287	-	0.139		1.432	32 Win	າ 6.935	0.039	9 6.703	3 7.085	
75	1,432	0.287	+	0.139	6.935	5 1.432	32					
85	1.432	0.287	1	0.139	6.938	9 1.432	32					
95	1.432	0.287	1	0.139	6.941		32					
105	1.432	0.287	1	0.139	6.942		32					
15	1.432	0.287	1	0.139	6.934		1.432					
25	1.432	0.287	1	0.139	6.927	1	.432					
135	1.432	0.287	1	0.139	6.929		1.432					
145	1 432	0.287	1	0.139	96.938	1.432	32					

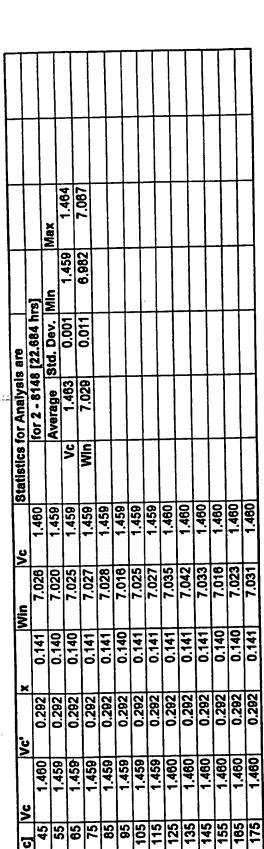




		-		-		-					-	1	1	\dashv
		Max	1.427	6.956										
	8]	Min	1.385	6.668										
are :	[23.558 hr	Std. Dev.	0.00	0.038										
Statistics for Analysis are	for 2 - 8462 [23.558 hrs]	Average Std. Dev. Min	1.427	6.869										
Statistics f			Vc	Win										
Vc	1.428	1.428	1.428	1.428	1.428	1.428	1.428	1.428	1.428	1.428	1.427	1.428	1.428	1.428
Win	6.929	6.930	6.923	6.910	8.944	6.933	6.934	8.908	6.930	8.928	6.918	6.918	6.928	6.952
	0.139	0.139	0.138	0.138	0.139	0.139	0.139	0.138	0.139	0.139	0.138	0.138	0.139	0.139
Vc.	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.288	0.288	0.288	0.288	0.288	0.288	0.286
Ve	1.428	1.428	1.428	1.428	1.428	1.428	1.428	1.428	1.428	1.428	1.427	1.428	1.428	1.428
Time [sec] [V	6	59	69	79	88	66	109	119	129	139	149	159	169	179







Time [sec]





me [gec]	۷c	Vc.	X	Win	Vc	Statistics	Statistics for Analysis are	s are			
7=	1 482						for 2 - 858	for 2 - 8586 [23.904 hrs]	[8]		
51	1 462						Average	Average Std. Dev.	Min	Max	
9	1.462					NC.		0.001	1.480	1.465	
1	1.482					Win	7.027	0.012	8.978	7.085	
81	1.462	0.293	0.140	7.023	1.462						
91	1.482	0.293		7.028	1.462						
102	1.482	0.293		7.037	1.462						
111	1.462	0.293			1.462						
121	1.462	0.293	_	7.011	1.462						
132	1.462	0.293		7.024	1.482						
142	1.462	0.293	0.141	7.027							
152	1.462	0.293		7.016	1.462						
182	1.462	0.293	0.140	7.018	1.482						





						_								_								
			Max		1.46/	7 187	2															
			u		1.458	A 087	0.90															
are		[17.872 nn	790		0.003	7100	2.0.5				_				1							
Statistics for Analysis are		[for 2 - 6420 [17.872 nrs]	Assessed 18th Day Min	Average	1.484	1 220	/.020					+										
Otatiotics 6	Comenand				Λc		Min															
	1	1.458		1.455	1 458	2	1.457	1.457		1.457	4 4EA	200	1,458	93,	1.455	1.458	4 450	1.430	1 45A	2017	1.430	
	Nam Na	7 005	20:1	7.019	A DOR	0.000	7.012	7 017		7.010	1 010	4.018	7 025	2	7.013	7.022	9,0	9L0./	7 048	50.7	7.020	
	S	0 4 40	2	0.140	0770	0.140	0.140	0 4 40	2.1	0.140	1	0.140	0 440	2	0.140	0 140		0.140	0770	0.140	0.140	
	<u>×</u>	L	0.282	0 292	1000	0.282	0.292	0000	747'0	0.292		0.282	0000	0.292	0.292	0 202	707.0	0.292	000	0.292	0.292	
	<u>`</u>		1.455	1 45B	201	1.456	1 457			1 457	132	1.458	647	1.450	1 458	977	004.1	1.458		1.458	1.458	
	Ima faar Vc	1	43	5	20		72	2 3	933	63	88	103		113	123	235	133	143	2	153	183	-))





Sheet1

 -							
	GRAPHIN	G of 20 CM	Control E	xperimenta	l Points		
	Vc	Win	Vc-SD	Win-SD	Date	%-Vc-SD	%-Win-SD
	2,102	9.927	0.005	0.034	5-Mar	0.24%	0.34%
	2.355	11.085	0.012	0.013	6-Маг	0.51%	0.12%
ļ	2.160		0.004	0.012	6-Mar		0.13%
 	2.453		0.006	0.011	7-Mar	0.24%	
— —	1.084	4.932		0.049	7-Mar	0.88%	1.00%
	1.299			0.008	8-Mar	0.08%	0.13%
	3.451	14.982		0.018	8-Маг	0.17%	0.12%
	3.664	15.885			9-Mar	0.14%	0.08%
 	0.174			0.007	9-Mar	0.57%	0.66%
	0.000				10-Mar	0.00%	2.00%

prise to Added Insolation

S

														_		_			_			7
+				+						1					1							
		Max	- C 7 7 7	7117	8.888										+							
	[8		1	2.097	9.843																	
	o non statistics from 2589-4047 [8.12 hrs]	100 71		0.005	0 034				:				+									
	rom 2589-4	2004 110	Average Std Dev	2.102	0 077	0.027																
	Statistics f	Orginaliza		Vc	100	WIL																
۸c	1	0.000	000.0	0.000 Vc	0000	0.000 WIR	0.000	0.000		0.084	0.129	00,0			0.287	0 329	١			0.442	0.477	0.510
Win	520	0.053	0.059	0.081		0.083	0.181	8.095	9.947	9.950	0 028	2100	9.914	9.903	9.922	Q 028	0.020	9.842	9.938	9.952	9.952	9.925
	-	0.001	0.001	000	3	0.001	0.003	0.182	0 199	0 199	100	0.100	0.198	0.198	0.198	100	0.188	0.189	0.199	0.199	0.199	0.188
2		0.000	0000	000	200.0	0.000	0.000	0000	0 00	0.013	900	0.020	0.038	0.048	0.057	900	0.000	0.073	0.081	0.088	0.095	0.102
		000.0	0000		0.00	0000	0000	000	2000	Pag o	100.0	0.128	0.189	0.241	0.287	0.50	0.328	0.368	0.408	0.442	0.477	0.510
Г	Time sec vc	82	405	200	C7L	145	185	And	200	202	077	245	288	288	800	000	328	346	388	288	800	428

20 cm Control 10-wall print X Th One 10-wall print

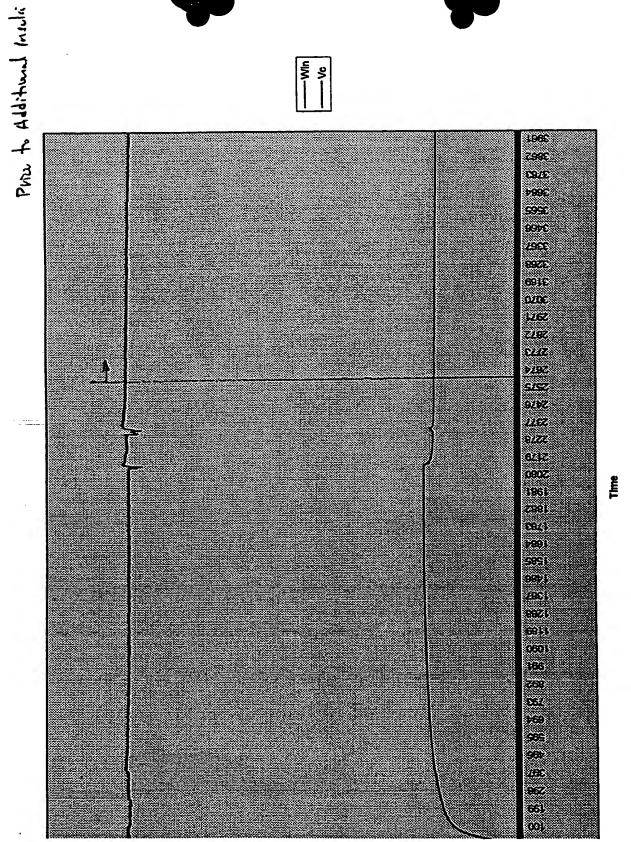
Ve 2.102 0.005

Win 9.527 0.034

Page 1











_		-	_		_			_		_	_		_		_	_	_		1	7	
	4.04 h.		MI 4.25 W/S	Max		2.369	44 408	۱			7.100	0 A07									
	Н	٦,	10 Watt poi	Min		2.328		11.040			2.148	0 643									
	250 744 we	Z.USO STATISTICS ITOM SOUTION IN WAIL BOILE.	and from 3000-3759 [10 watt point]	Assess 1944 Day	OLU DEV	0.012		0.013	-		0.004	25.5									
_	4 900 men	HOLLI SOO	and from	A.:0200	Average	2.355		11.085			2.180	623	8.3/3		-						
	00100100	असाहाट	-		2.096 11-Watt	3/75		2.096 Win	2 000 40 wett	יט אמוו	2.103 Vc		2.109 WIN	4		0	2		5	5	
\ <u>\</u>			2 098			2 NOR Ve								2114		2.120	2.125	١	2.130	2.135	
Win		9.884	O RRO		9.828			11.031	14 046		11 050		11.050	44 045		11.052	11.051		11.046	11.073	
,		0.197	A 407		0.197		0.604	0.221	١	L7770	0 221		0.221			0.221	0 224	١	0.221	0 221	
		0.419	0 110	0.418	0.419		U.418	0.419		0.420		0.461	0.422		0.423	0.424			0.428		_
		2.098	900	2.095	2 noat	4.000	2.086	2 098		2.099	2 402	6. 103	2 109		2.114	2.120	2 425	671.7	2.130	2 425	Z. 133
Γ	me [sec] vc	187		207	700	177	247	2A7	3	287	100	20%	100	25.	347	387	100	700	407	127	177

20 cm Cantr 1

11 wath

X Gn

Ve 2,355 0.012

Win 11.085 0.013

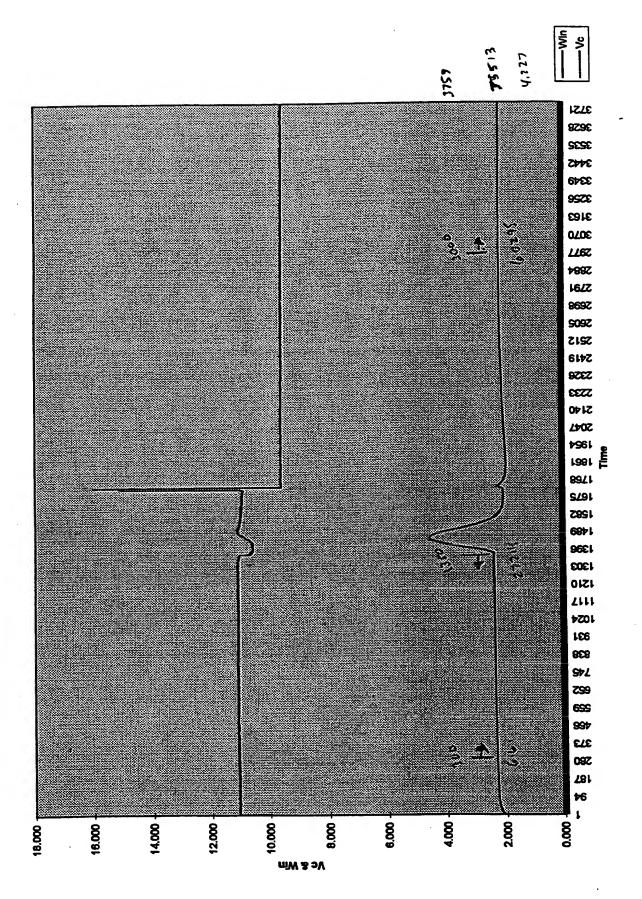
10 wath

Ve 2.160 0.004

Win 9.573 0.012







ane 1



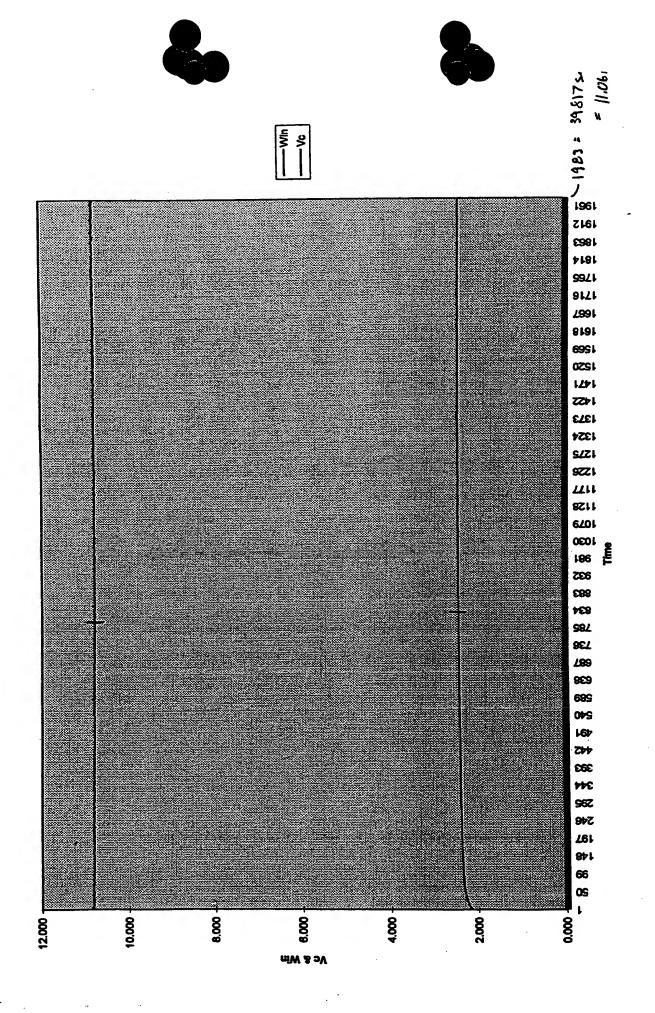
1696 See 17 6.36 hours

TP030797

_		_	_	_		т-	7	_	_	_		<u> </u>	_	_	_	_	7
-		1	Max	2.464	10 848	22											
				2.439													
``		205	Std Dev	0.00551	1	0.01100											
1			Average	2 453	200	10.808											
		Statistics		1/0	١,	Win						 					
5	- 1	2.168	2.170	0.474	Z. 1 / # V.	2.179 Win	2.184	2.190	2.195	2.201	2.208	2.210			2.222	2.228	2.230
AA/A		10.557	10 847	270	10.642	10.840	10.838	10.851	10.833	10.824						10.828	10.818
		0.211	0 247		0.217	0.217	0.217	0.217	0.217	0.218	0 217	0 217	0 217	0.218	0.218	0.217	0.218
	×	0.433	0.424	2.4.2	0.435	0.438	0.437	0.438	0.439	0 440	0 441	0.442	0.443	0.444	0.444	0.445	0.448
		2.168	4.70	2.1%	2.174	2.179	2.184	2 180	2 105	2 201	2 208	2240	2 24.6	2 210	2 222	2 228	2.230
	Time [sec] Vc	e	3	BL.	139	159	179	9	210	020	250	070	8/2	320	340	OBC OBC	380

20cm central

Il wat point $\frac{x}{k}$ $\frac{x}{2.453}$ $\frac{q_n}{0.0055}$ Win 10.606 0.011



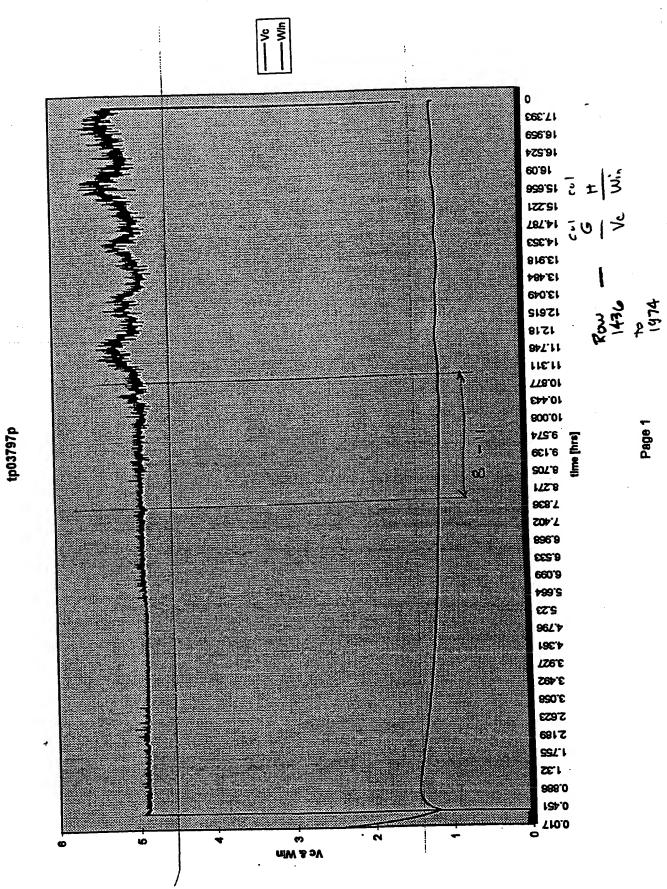
Page 1



	_				_	_	_	_	_		_	_	_		_	_			_	_	7		1
				1.105	5.179					İ													
_	\mid	4	Max	97	4 70	2	+	+	_		+	+		-	+	+	-		-	\dagger	_		
			_	1.067		۲						Ì											
_	+	-	<u>M</u>	58	a a	3	+	\dashv	_		\dagger	+	_	-	\dagger	1			\dagger	\dagger		-	l
\		=	Std. Dev. Average	1 084258	4 024	4.831000																	
_	 	lour 8	<u>∀</u> .∨	0 000543		U.048132	1				1				1				T	1			
		rom	Std. D	000		5.0												L	\downarrow				
		3.637 Statistics from Hour 8-11				اء																	
-		37 St	0 113	77 700 0		0.081 Win	0.088	0.083	0 071	1	2	0.079	0.077		0.0/4	0.074	0.073	0 074		0.061	0.057	0 064	3
(LIV.	3.8	0		3	6	0.0	0.0	0		5	ö	٥		5	ö	ď	6	١	Ö	0	٥	١
	>	2.459	245		7.461	2.381	2.339	2.298	2 250		7.77	2.185	3 45		2.118	2.084	2052	5	770.7	1.993	1 985	2	1.837
		1		ľ	7	N	7			١										•	L		
	Time (hrs) VC	0.017	0000	0.022	0.028	0.034	0.039	0.045	0.05	20.0	0.056	0.082	1900	0.00	0.073	0.078	ARO O		0.089	0.095	5		0.100
	E	3 837		0.113	0.094	0.081	0.088	O DR3	760	5	0.075	0.079	į	2,20	0.074	0.074	220	2	0.071	0.081	0.057		0.051
	Ę	6	٥	اد	0	Ö	0		اد	اد	Ö	0	ľ	۲	0	6	٦	ا (0	0	١	۲	-
		0 073	2 6	0.007	0.002	0.002	000	200	3 3	50.0	0.007	0000		0.002	0.001	000	300	0.00	0.0	0.001	130	1.001	0.00
	X		7	9	4	8	Ι α) 0	0	2	4	10		3	23	1		=	*	g		2	87
		0 402	2.4	0.49	0.484	0.478	O ARR		0.40	0.452	0.444	0.427	5	0.43	0.423	0 447	5	0.41	0.404	0 39R		0.393	0.387
	<u>خ</u>		2	55	71.	7	9	3 2	2	29	21	1 4	3	2.15	2 118	2 2	5	2.052	2.022	4 002	3	.985	1 027
		ı	2.438	2.45	2.421	2284	2 220	2	2.280	2.259	2 221	2 405	į	ri	24	i	Z.004	2.0	2.0	i	-	7.5	10
	1	3	61	8	٤	2 5	77		181	181	25.		777	241	cac		107	302	322	1 5	775	382	Cac
	3	וווום (פפרו מה			-			-	-	_	1	ٵٛ	7			1	7	••				- 0	

20 cm. Control 5wath point $\frac{X}{X}$ $V_{c} = 1.084$ 0.0095Win = 4.932 0.0491





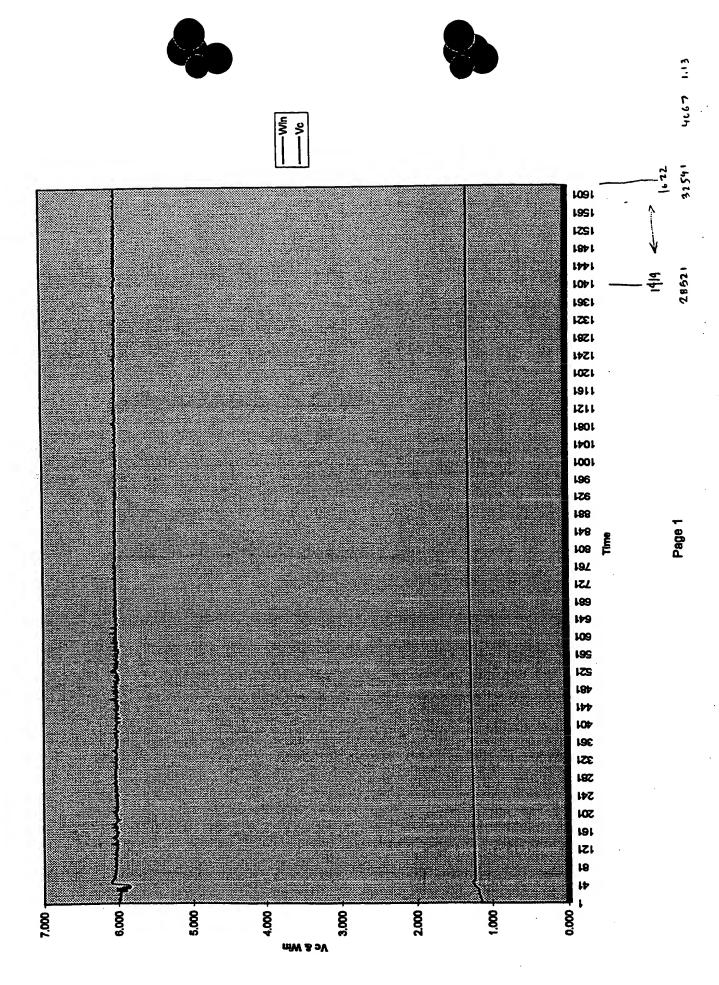




Ī														
		Max	1.301	6000	0.033									
	hrs]	_	1 297		2.887									
	135 Statistics from 1419-1622 [1.13 hrs]	Average Std Dev Min	0 00 0		0.008					A 14				
	from 1419-	Average	4 200	1.500	6.009									
	Statistics			2	Win	·								
Š	1.135	1 137	1	1.138 VC	1.141 Win	1.144	1.146	1.148	1.150	1.152	1.154	1.158	1.158	1.161
Win	5.960	ļ		6.001	5.892	5.995	6.002	5.974	5.974	5.872	5.982	6.009	5.980	5.980
	0 119	420	0.120	0.120	0.120	0.120	0.120	0.119	0.119	0.119	0.120	0.120	0.120	0.120
C ,SA	7660	2000	0.227	0.228	0.228	0.228	0.229	0.229	0.230	0.231	0.231	0.231	0.232	0.232
\\	4 425		1.13/	1.139	1.141	1.144	1 148	1 148	1 150	1 152	1.154	1.158	1.158	1.181
me [sec]	+		131	151	171	191	211	231	251	271	291	344	331	354

20 cm control
6 wath print

V. 1,299 0.001
Win 6.009 0.008

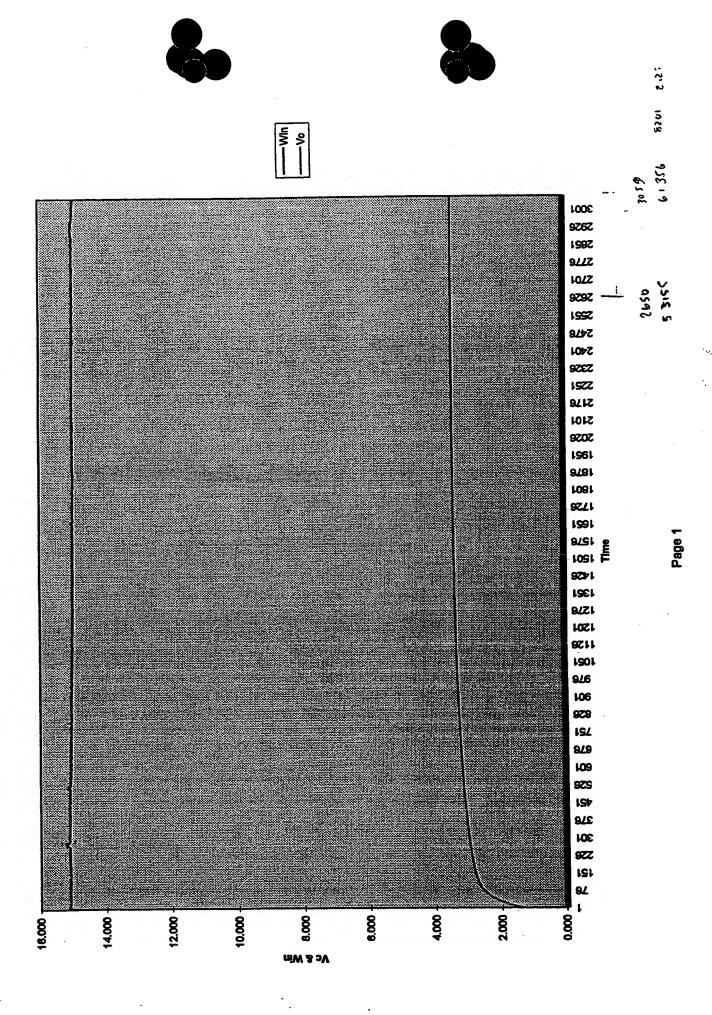






			Max	2 4A1		15.034				-						_					_	
	11 c	0110	<u>E</u>	2 444	١	14.937	L															
	POEG 9 978	2000 4.410	Std Dev	900	0.000	0.018				,			7.									
-	Case To	.301 Statistics from 2000-2005 4.470 ins	Average Std Dev Min	73, 6	3.451	14.982				•												
	4 - 41 - 41 - 4	Statistics I			\ \	Win																
Ş	F	1.301	4 322	1,054	1.358 VC	4 207 Win	1.001	1.437	3677	1.4/3	4 840	1.016	1 54R	1.01	1.583			1.649		1.678	4 700	3
Win		14.686	44 800	14.090	14.938	44 064	14.831	15.071	1	15.104	45 440	13.110	46.400	13.160	15,141		15.145	15 145	2	15.148	16 494	13.131
		0.294	000	0.500	0.299	600	0.298	0.301		0.302		0.302	000	0.303	0.303	3	0.303	0 202	200.0	0.303	000	0.303
2	۲ ک	0.280		0.204	0 271		0.279	0 287		0.295		0.302	9	0.310	0 217	2	0.323	0000	0.00	0.336		0.342
	\ \	1 301		1.322	4 25R	20:-	1.397	1 437	12	1 475		1.512		1.548	4 602	1.303	1.816	40,	1.648	1.879		1.709
	ime [sec]	A	5	8	405	3	124	446	2	184	101	185	2	205	1	C77	245		285	285		305

20 cm Contel 15 wath point 16 3.451 oroce Win 14.982 0.018







	2 452 Semelating from 770-1144 [1 944 hrs] for 16 watt point	The same of the bash for 4 moth moint	III.	Average Std Dev Min Max	3,684 0.005 3.853 3.871	45 ARS 0 012 15.857 15.93	1			1.054 0.007 1.039 1.078			0.174 0.001 0.173 0.178	1000						
	ı	3.433 Statistics II	3.455	3.459 16-watt		0 400 Min	3.400 WILL	3.47 1 Watt	3.473 Vc	2 478 Min	3.470 99111	3.479	Cal C	3.405	3.485	3.488	3.49	2 403	3.483	7 VOY C
Win	100	0.316 318.0	0.318 15.783					0.317 15.832	0.317 15.841		0.317	0.318 15.878		0.317	0.317 15.865	0.317 15.855		1	0.317 15.6/2	100 YT
, J.	<	0.691 0.3	0.891 0.3				0.693 0.3	0.695			0.686	O ROR O		0.687	0.697 0.3				0.699 0.	2000
		3.453	3 455	2 450	3.438	3.403	3.488	3.47	2 472	0.470	3.478	2 470	0.410	3.482	3.485	2 488	2,400	3.48	3.493	-
Who are the	IIMe Iseciac	2	g	200	8	138	159	170	6	981	219	220	BC7	259	279	000	227	BLE	338	



9 5 5
Nin 0.050
3

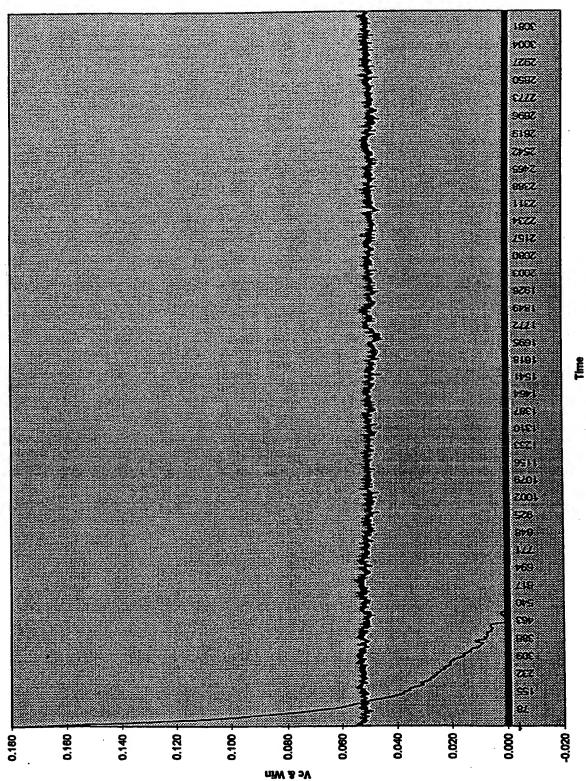
_		_	_	_			Т.	7		_	_		Т	7		<u> </u>	-		<u> </u>	Т	_	
			-	_						1												
		-	×	0.001	0.055	23.5								_								
		1	Max	0000	2000											1	-					
	Post Post	0.07	ev Min	000	0.000	1.00.0		-			-								1	_		
-	70 07 70 0	0.174 Statistics from 502-314/ [16.6/ III.5]	e Std D	000		200			+							_	_			_	-	
	* { - -	s from 50	Averac		ò	Ö		-			-	1		-				1			-	 -
		Statistic			2	0.188 Win	-		- -	60	_		9				a	2 0	3	 -	- 6	2
	ΛC	0.174	١					١		0.158	١		0.153			0.148		2		0 141	١	0.138
	Win	0.048	620	0.033	0.054	0.053	0.054	1000	0.053	0.055	7300		l	١	0.053	0.054	200	0.034	0.054	0.062	0.032	0.053
	<u> </u>	000	1	0.001	0.001	0 001	1000	100.0	0.00	000		0.001	000	20.0	0.001	0.001		0.001	0.001	7000	0.001	0.00
	×	2000	0.033	0.034	0.034	0.033	2000	0.033	0.032	0.032	4.002	0.031	1000	1.00.0	0.030	0000	0.020	0.029	0.028	2 3	0.028	0.028
	ζς.	1	0.1/4	0.172	0 189	486	200	0.183	0.181	150	0.130	0.158		0.153	0.151	07.7	0.140	0.148	0 443	2	0.141	0.139
	25								188		20/	0 866		247 0	2AA 0		288	308		320	348 0	368
	Timo food		87	107	764	171	4	167	1		7	6	7	Ä	Š	1	7	Č	Š	ò	Ċ	(F)

TP031097



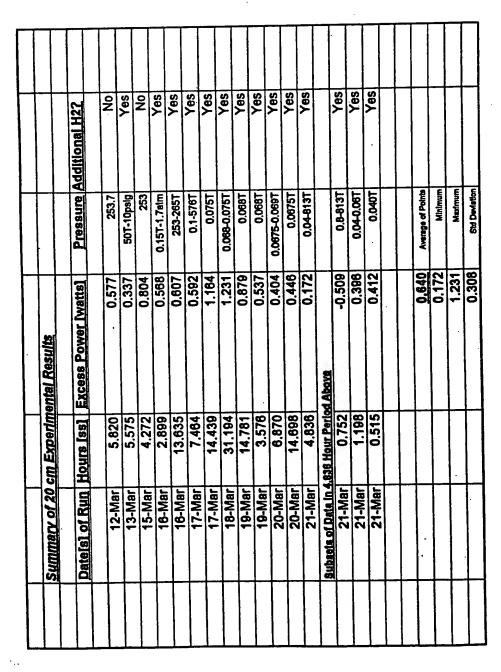






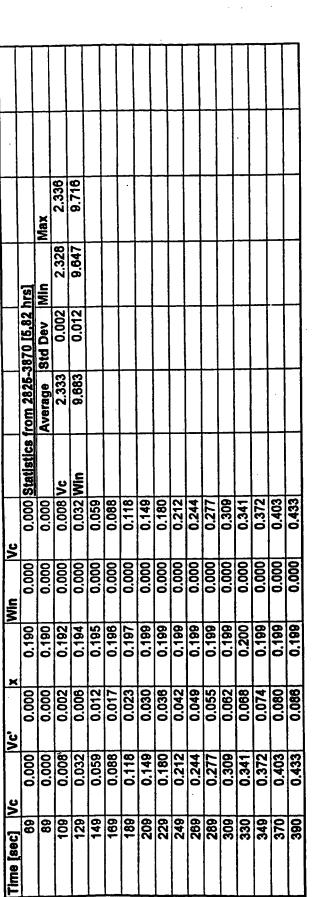






Summary of Exc. Power Produced

8



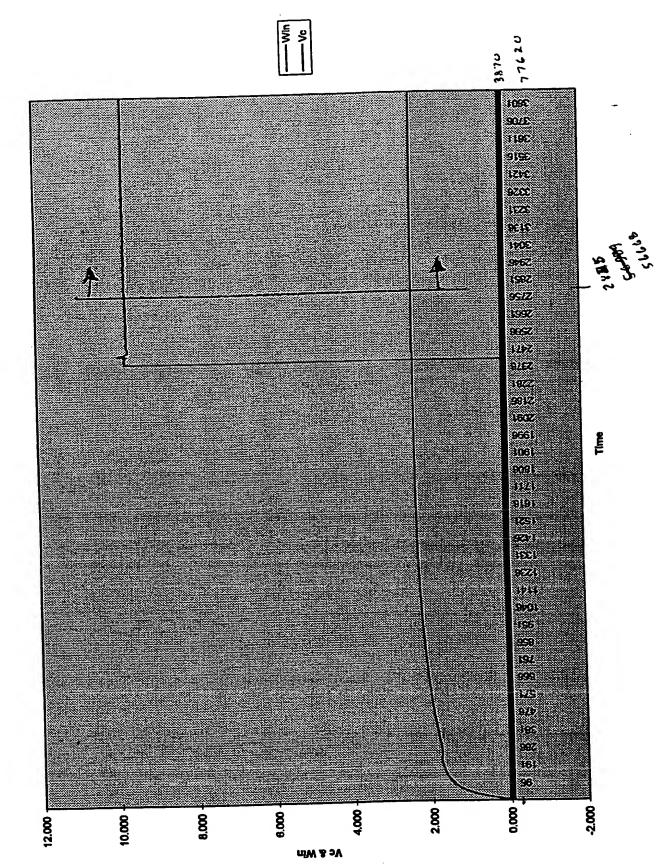
From Calibration Line Vc : 2,333 = 10.260 wats exprested.

excess walts * 0.577









Page 1

	-																_
			2.378	866.6													_
		Max		8													
		Min	2.309	9.657													
	(6.575 hrs	Std Dev	0.00	0.080													
	2.333 Statistics from 2-2004 [5.575 hrs]	Average S	2.323	9.880													
	Statistics f	,	Vc	Win													
\chi_c	2.333	2.333	2.333 Vc	2.333 Win	2.334	2.334	2.334	2.334	2.334	2.334	2.334	2.334	2.334	2.334	2.333	2.333	2.334
Win	9.696	9.684	9.690	9.686	9.714	9.693	9.695	8.692	869.6	9.878	9.657	9.694	9.705	9.694	9.723	9.708	9.682
2	0.194	0.194	0.194	0.194	0.194	0.194	0.194	0.194	0.194	0.194	0.193	0.194	0.194	0.194	0.194	0.194	0.194
×	0.486	0.467	0.467	0.467	0.467	0.467	0.467	0.487	0.467	0.467	0.487	0.467	0.487	0.467	0.467	0.467	0.467
\c \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	2.333	2.333	2.333	2.333	2.334	2.334	2.334	2.334	2.334	2.334	2.334	2.334	2.334	2.334	2.333	2.333	2.334
Time [sec] \	45	55	92	78	85	98	108	118	128	138	147	158	166	178	186	198	208

From Calibration Line.

Ve = 2,323

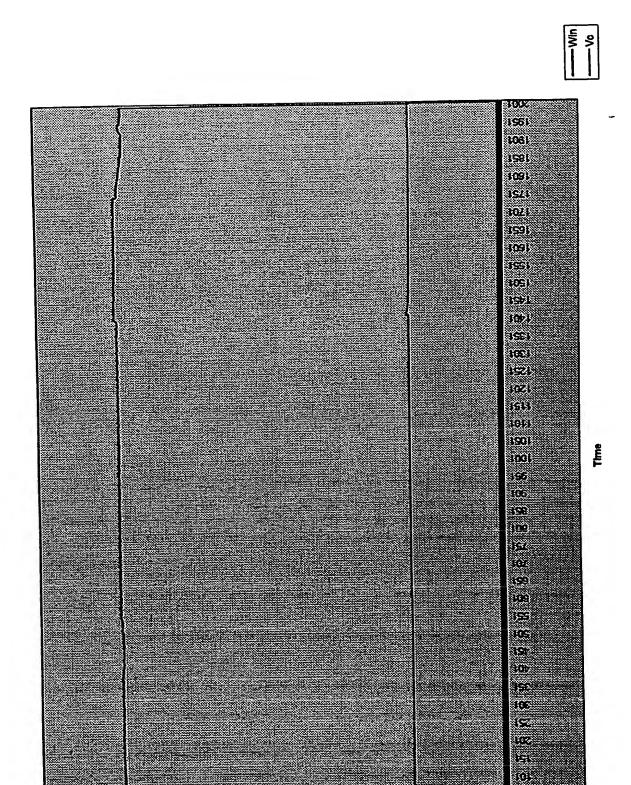
Ve = 10,217 wetts expressed

exact watts [0,337 wetts]

9.000 9.000 8.00

TPO31397 Chart 1





2,000

Page-1

|--|



_		_		T	—		_	<u> </u>	<u> </u>						-	-	_
		Max	2 437		9.945						-						
	72 hrs]	Min	2 300		9.671												
	0.000 Statistics from 5555 to 7089 [4.272 hrs]	Std Dev	0 040	-	0.056												
	from 655 5	Average Std Dev			9.824												
	Statistics 1		-	VC	Win												
× ×	0000	000	2000	0.000	0.000	0.004	0.023	0.044	0.087	0.089	0.111		0.152	0.171	0.189	0.207	0.224
Win	0000	000	200.0	0.000	0.000	3.982	3.951	3.957	9.858	9.797	9.818	9.817	9.815	9.801	8.808	9.798	9.724
×	0.011	0 150	0.10	0.196	0.198	0.198	0.198		0.197	0.198	0.198	0.198	0.198	0.198	0.198	0.198	0.194
<u>.</u>	0000	0000	0.000	0.00	0.000	0.001	0.004	0.00	0.013	0.018	0.022	0.028	0.030	0.034	0.038	0.041	0.045
Vc Vc	0000	200	0,000	0.000	0.000	0.004	0.023	0.044	0.087	0.089	0.111	0.132	0.152	0.171	0.189	0.207	10 224
ne [sec]	9	9	a.	69	79	68	66	109	119	129	139	149	159	169	179	189	199

From Calibration Line.
Vc = 2.419

10.628 walls expected

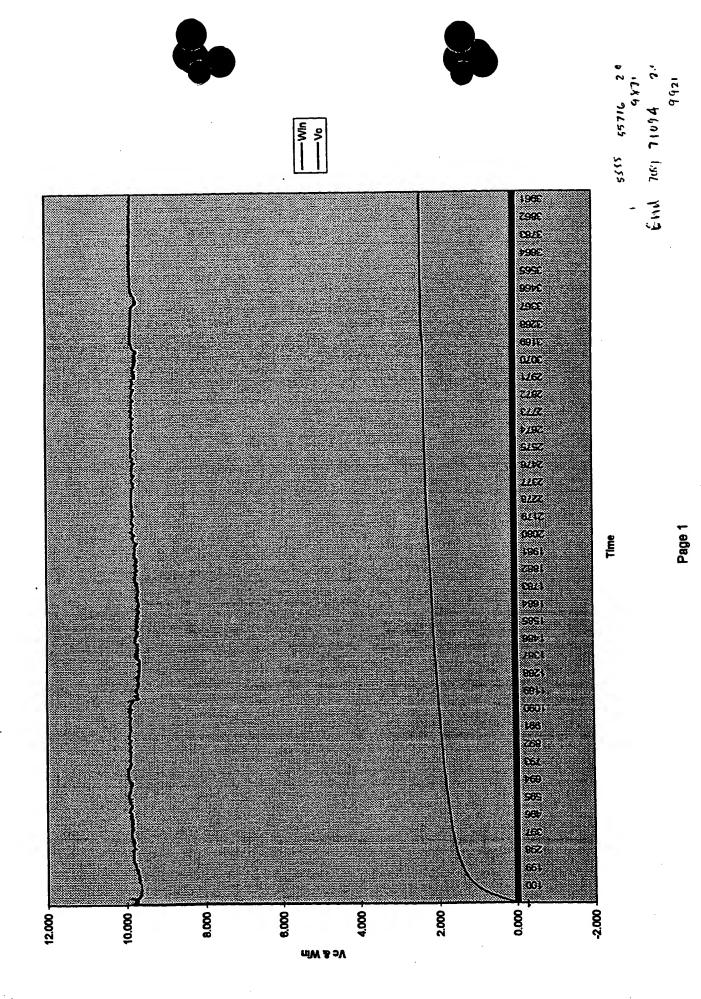
= 10.628 walls expected

= 10.628 walls expected





								
	Win	Predicted \	<u>/c</u>					
	0	-0.0605		Given Vc=	2.419			
	1	0.1728		Estimated		106 -0		
	2	0.4061		Watts Out	10.628	watts of po	wer	
	3	0.6394		Actual =	9.824	watts of inp	out power	
	4	0.8727			0.804	excess wat	ts of power	produced
	5	1.106					<u> </u>	
	6							
	7	1.5726						ļ
	8	1.8059					<u> </u>	
	9	2.0392						
	10	2.2725						
	11					ļ		
	12			L		 	 	
	13			L		 	 	
	14			 		 		+
	15			 			 	
	16			 		 	 	
F. F	·			1			 	+







_	_	_	_		_	_	_	_	_	_	$\overline{}$	Т	_	_	\neg	_	Т	Т	7
																		•	
			Max	2.438	10.081				1										
	lou.			2.299	9.442														
	1 000 FT 371	10 (4.050	Std Dev Min	0.042	0.140														
	20.00	2.438 Statistics from 2 to 20/0 (4.659 iii.s.	Average	2.350	9 785	3													
		Statistics 1		Vc															
N.	ı	2.438	2.438	2 438	2 428			2.438	2.438	2.438	2.437	2.437	2.437			2.435	2.435	2.434	2.434
Win		9.791	9.743	0 777	0 704	9.701	9.785	8.799	9.814	9.753	9.798	9.780				9.716	9.798	9.815	9.789
	*	0.198	0 195	108	0.190	0.183	0.195	0.198	0.198	0.195	0.198	0.198	0 195	0 195	0.195	0.194	0.198	0.198	0.198
1		0.488	O ARR	007.0	0.400	0.488	0.488	0.488	0.488	0.487	0.487	0.487	0.487	0.487	0.487	0.487	0.487	0.487	0.487
	ΛC	2.438	BLY C	2.430	2.430	2.438	2.438	2.438	2.438	2.438	2.437	2 437	2 437	2 438	2.435	2 435	2.435	2.434	2.434
	Lime (sec.)	15	33	77	22	<u>9</u>	35	40	45	202	55	S C	9	3 6	75	2 6	85	06	95

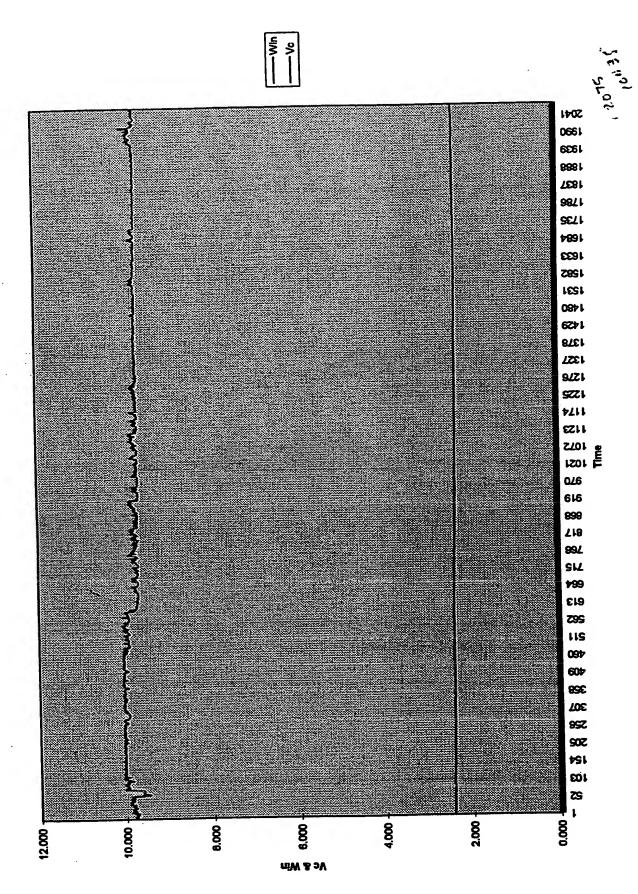




Win	Predicted	<u>Vc</u>			
0	-0.0605	Given Vc=	2.350		
1	0.1728				
2	0.4061	Watts Out		watts of power	
3	0.6394	Actual =		watts of input power	<u> </u>
4	0.8727		0.568	excess watts of power	produced
5	1.106				
_ 6	1.3393				
7	1.5726				
8	1.8059				
9					
10					
11	2.5058				
12					
13					
14					
15					
16	3.6723				
	L				
					<u> </u>







age 1



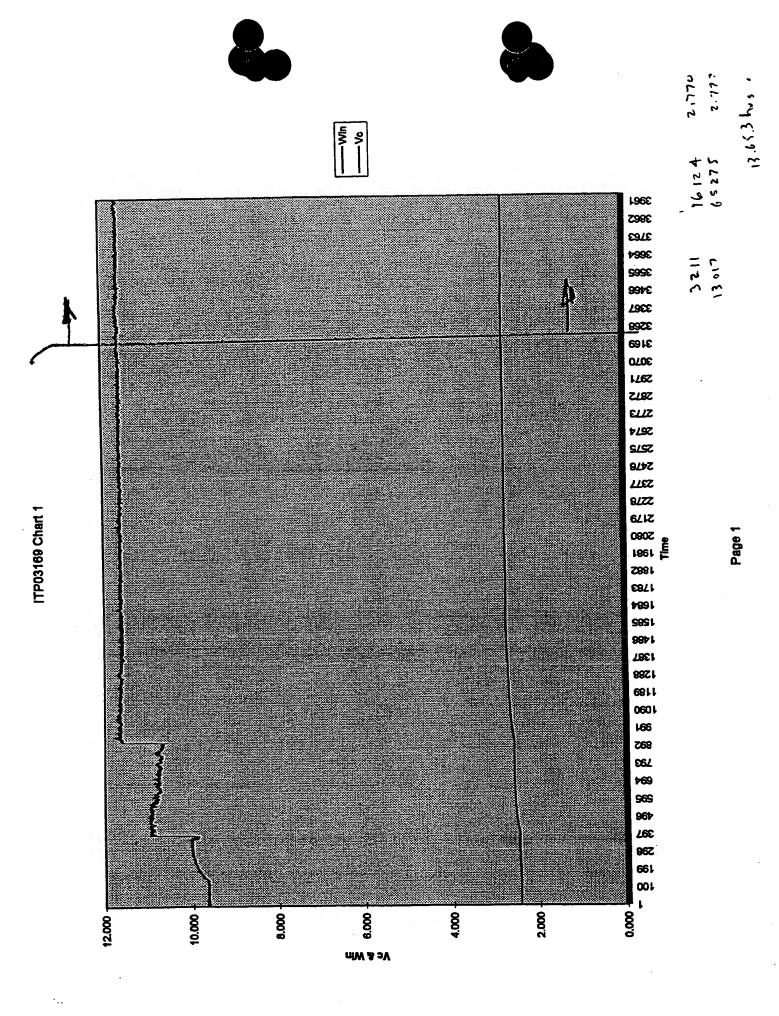


			1														
		Max	2.827	11.787													
	3.635 hrs]		2.767	11,531													
	2.434 Statistics from 3211 to 13017 [13.635 hrs]	Average Std Dev Min	0.018	0.035													
	rom 3211 1	Average	2.793	11.824													
	Statistics 1		3/	Win													
Vc	2.434	2.434	2.434	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435
Win	9.647	9.658	9.680	9.660	9.650	9.685	9.657	9.684	9.683	9.658	9.635	9.643	9.641	9.652	9.680	9.680	9.678
	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.194	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.194	0.194
Vc* x	0.487	0.487	0.487		0.487	0.487	0.487	0.487	0.487		0.487	0.487	0.487	0.487	0.487	0.487	0.487
۷c	2.434	2.434	2.434	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435
Time [sec]	39	44	48	54	59	84	69	74	79	88	88	84	66	104	109	114	119





	Min	Predicted V				
			Given Vc=	2.793		
	0		Estimated			
	1	0.1728		40 224	watts of power	
	2	0.4061	Watts Out			
	3		Actual =		watts of input power	<u> </u>
	4	0.8727		0.607	excess watts of power	produced
	5					
	6					
	7	1.5726				
	8	1.8059				
	9					
•	10					ļ
	11	2.5058				
	12					
	13					
	14					
	15	3.439				+
	16	3.6723				
						<u> </u>









_	_	7	Т	Т	Т	\top	Τ	Т	\top	Т	Т	Т	Т	T	Т	Т	Т	Ţ	Т	7
																		١		
_	-	+	4	\dashv	+	+	+	+	-	+	+	-	$\frac{1}{1}$	\dashv	+	+	+	+	+	\dashv
_	+	+	-	8	55	\dashv	+	1	\dashv	+	+	+	+	\dashv	\dashv	+	+	\dagger	\dagger	\dashv
			Max	2.893	11.945															
_	t			2.733	11.523	1	1													
		<u>.</u>	Min																	
		1.4041		0.050	0.054															
_		283	Std												_				_	4
		2 10 1	Average	2.798	11.852		Ì											ļ		
	╡.	From	Ave	Ü				_			_	_		Н	_			-	-	4
		2.773 Statistics from 2 to 5363 [/.464nrs]		Vc	Win															
L		73 S t	73	73	73	73	73	2.773	2.773	2.773	2.773	2.773	2.773	2.773	2.773	2.773	2.773	2.773	2.773	2.773
١.	ı	2.7	2.773	2.773	2.773	2.773	2.773	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.	2.	7	7
	3	327	318	11.64	341	319	303	11.624	11.614	11.607	11.643	11.625	11.604	11.843	11.649	11.678	11.68	11.668	11.66	11.84
إ		11.627	11.818	-	11.641	11.619	11.603	1	11.	11.	1.	11.	11.	=	Ξ	Ξ	+	11.	1.	+
F	5	0.233	0.232	0 233	0.233	0.232	0.232	0.232	0.232	0.232	0.233	0.233	0.232	0.233	0.233	0.234	0.234	0.233	0.233	0.233
	J	0	0		0	0	0	0	0	0	0	0	P	0	ľ	0	ľ			0
ľ	×	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555
	>	0		7																
ľ	_	2.773	2773	2773	2,773	2.773	2.773	2 773	2.773	2773	2.773	2773	2773	2773	2.773	2.773	2.773	2.773	2.773	2.773
	ပ >	1		"																
	ime [sec]Vc	27	20	3 6	2 64	48	52	57	62	87	72	77	82	3 6	3	16	102	101	112	117
	Ē																			

TP031797

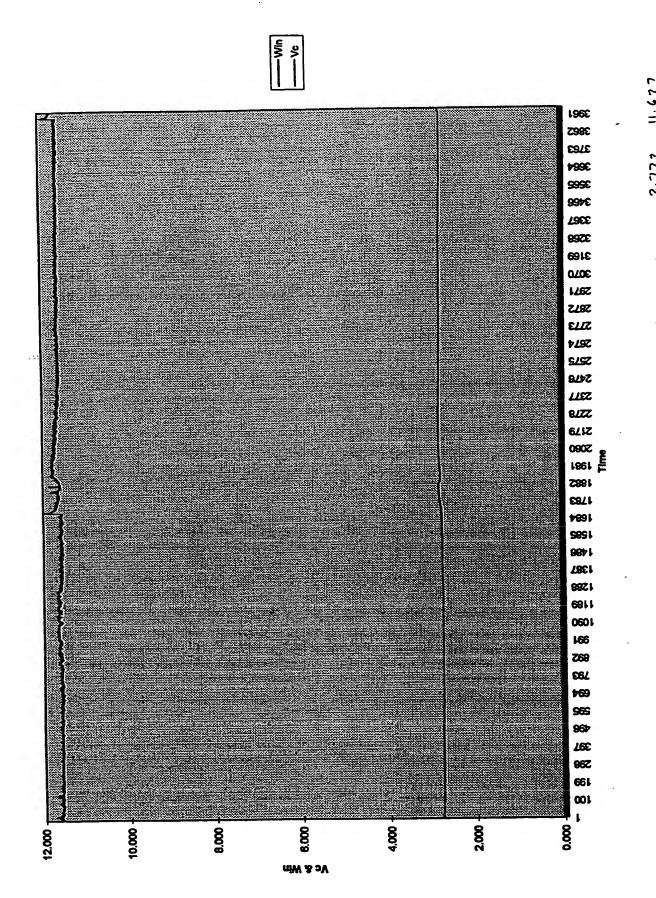




				T	-			
 	Win	Predicted \	/c					
	0	-0.0605		Given Vc=	2.796			
	1	0.1728		Estimated				
	2	0.4061		Watts Out		watts of po		
	3	0.6394		Actual =		watts of inp		
	4	0.8727			0.592	excess wat	ts	
	5	1.106						
	6	1.3393						
	7	1.5726						1
	8	1.8059						
	9	2.0392						
	10	2.2725						
	11	2.5058						
	12	2.7391						
	13	2.9724						
	14							
	15							
	16	3.6723						
					<u> </u>			<u> </u>
				<u></u>	<u></u>		<u> </u>	<u> </u>



Page 1



TP031797 Chart 1



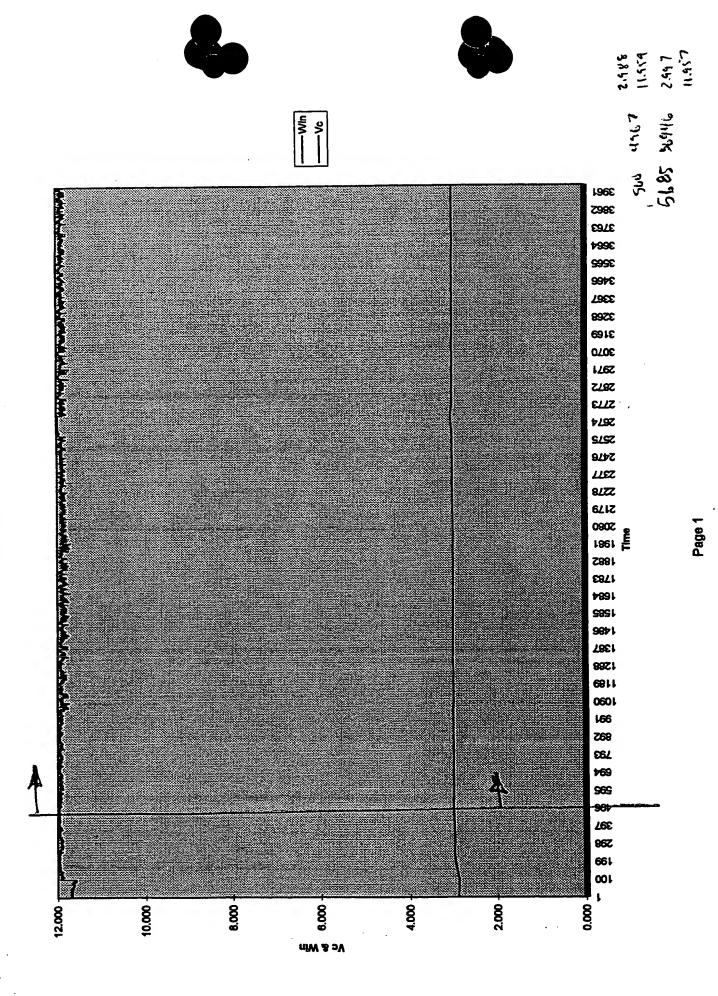


		_		3.019	988			 												
		Mov			11.998								1							
	139 hrs]	101-		2.968	11.700															
	2 092 Statistics from 500 to 5685 [14.439 hrs		Average Std Dev Will	0.008	0.082															
	rom 600 to		Average	2.985	11.890					4										
	Otatietine f	Calletion		Vc	Win															
Vc			2.882	2.882	2 882	2 882	4.004	2.882	2.882	2.882	2 882		2.883	2.883	2.883	2.883	2.883	2.883	2.883	
Win	000	1 1.000	11.670	11,889	11 884	44 070	11.07	11.680	11.692	11.703	11 RR7		11.688	11.691	11.681	11.892	11.690	11.684	11.667	
	7000	0.234	0.233	0 233	A5C 0	1000	407.0	0.234	0.234	0.234	A 224	7	0.234	0.234	0.234	0.234	0.234	0.234	0 233	
1/01	100	0.5//	0.577	0.577	0.577	20.0	1.0.0	0.577	0.577	0.577	0.677	2.5	0.577	0.577	0.577	0.577	0.577	0.577	0.577	
		2.882	2,882	Casc	2,002	2,002	7.997	2.882	2.882	2 882	Cooc	7.007	2.883	2.883	2.883	2.883	2 883	2 883	200 0	7.000
Men Page Me	וועם ופפרו	32	37	5	75	3	25	25	35	45	2 2	22	92	75	85	95	105	115	2 4	120





				\			
	Win	Predicted \			0.005		1
	0			Given Vc=	2.985		1
	1	0.1728		Estimated			
	2	0.4061		Watts Out	13.054	watts of power	┪──
	3	0.6394		Actual =	11.89	watts of input power	
	4	0.8727			1.164	excess watts	
	5	1.106		•			
	6					ļ	+
<u> </u>	7	1.5726					
	8	1.8059					+
	9	2.0392					
	10						
	11						
	12	2.7391					
	13						
	14						
	15					 	
	16	3.6723	3			 	
	1					 	







		Max	YBY	3.052	12.024										1						
	4 hrs]			2.860	11 558																
	2 000 statistics from 2 to 44498 [34 194 hrs]			0.070	0 180																
	from 9 to 4		Average Std Dev																		
	Otatiotion	Otaliones		Ϋ́		MIN			-						3		2				
Vc			3.009	3 008				3.007	3.008	3.005	3.005	3.004		١	3.003	3.003	3.002	3.001	3.001	3.001	
Win	7,		11.878	ľ			11.820	11.888	11.862	11.787	11.882	11 807	١		11.752	1	11.931	11.904	11.893	11.895	j
,	ا	0.238	0.238	0 227	0.601	0.238	0.238	0.237	0.237	0.238	0.238	A5C 0	203.0	0.235	0.235	0.238	0.239	0.238	0.238	0.238	
٧٠.		0.602	0 802	COAC	0.002	0.602	0.802	0.602	0.602	0.602	0.801	O AO4	20.0	0.601	0.601	0.801	0.601	0.601	0.601	0.601	
		3.009	2000	0000	3.000	3.008	3.008	3.007	3.008	3 005	3 005	700	3.003	3.004	3.003	3.003	3.002	3.001	3.001	3 001	2,22.2
Г	Tag all	9	5	2 8	00	06	100	110	120	131	140	27	DC!	160	170	180	180	200	210	220	123

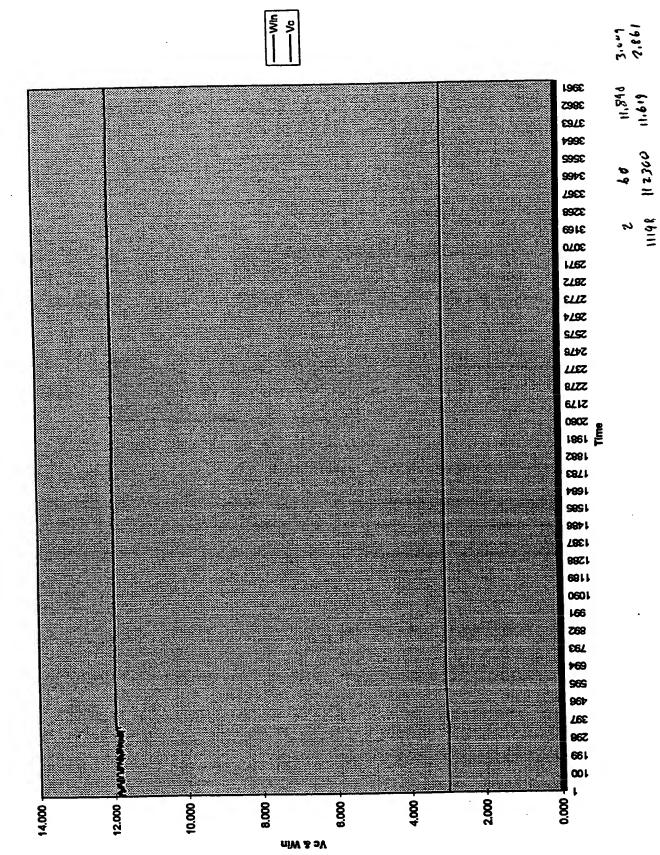




		<u> </u>					+
Win		Predicted \	/c				
	0	-0.0605		Given Vc=	2.999		
	1	0.1728		Estimated			
	2	0.4061		Watts Out		watts of power	
	3	0.6394		Actual =		watts of input power	
	4	0.8727			1.231	excess watts	
	5	1.106					
	6	1.3393					.
	- 7	1.5726					
	8	1.8059					<u> </u>
	9	2.0392					<u> </u>
	10						
	11						ļ
	12						
	13						
	14						
	15						
	16	3.6723					<u> </u>







age 1





		- 1	_				7		_	_	1	Т	_	\neg	Т	\neg	7
		Max	2.862	11.779				Max	2.849	11.982							
	hrs	Min	2.847	11.533		·	576 hrs]	Min	2.842	11.874							
	2.881 Statistics from 2 to 5310 [14.781 hrs]	Std Dev	0.004	0.024			2.861 Statistics from 5311 to 6594 [3.576 hrs]	Std Dev	0.001	0.011							
	from 2 to 6	Average	2.857	11.627			from 5311	Average	2.843	11.909							
	Statistics		Vc	Win			Statistics		Λc	Win							
Λc	2.881	2.861	2.861	2.861	2.861	2.861	2.861	2.881	2.881	2.861	2.861	2.881	2.861	2.861	2.860	2.861	2.861
Win	11.583	11.608	11.624	11.610	11.597	11.629	11.832	11.831	11.630	11.628	11.645	11.835	11.854	11.841	11.842	11.645	11.577
×	0.232	0.232	0.232	0.232	0.232	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.232
Vc.	0.573	0.573	0.573	0.573	0.573	0.573	0.573	0.573	0.573	0.573	0.573	0.573	0.573	0.573	0.573	0.573	0.573
Vc	2.861	2.861	2.881	2.881	2.861	2.861	2.861	2.861	2.861	2.861	2.861	2.861	2.861	2.861	2.880	2.861	2.861
Time [sec]	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	186	195





Win	Predicted	<u>Vc</u>				1
0			Given Vc=	2.857		1
1	0.1728		Estimated			1
2	0.4061		Watts Out		watts of power	\downarrow
3	0.6394		Actual =		watts of input power	1
4	0.8727			0.879	excess watts	1
5	1.106					4
6						4
7	1.5726				<u> </u>	4
8						+
9						4
10						4
11	2.5058					+
12						+
13					·	+
14						+
15				·		+
16	3.6723	1				+



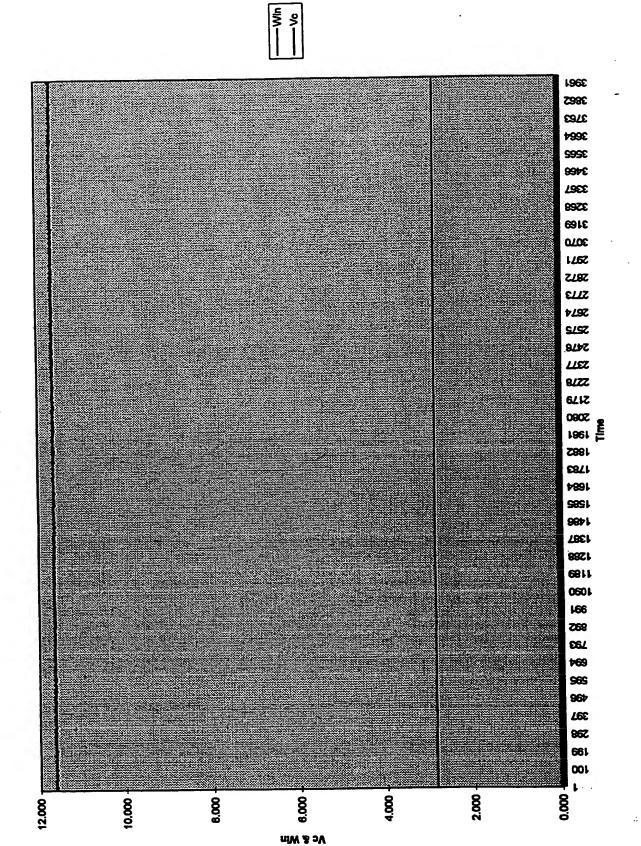


	Win	Predicted Vc				
	0	-0.0605	Given Vc=	2.843		
	1	0.1728	Estimated			
	2	0.4061	Watts Out		watts of po	
	3	0.6394	Actual =		watts of inp	
	4	0.8727		0.537	excess wat	ts
	5	1.106				
-	6				·	
	7	1.5726				
_	8	1.8059				
	9					
	10					
	11					
	12					
	13					
	14					
	15				ļ	
	16	3.6723				



43346

5311 6594



TP031997 Chart 1

Account the second

.

.





_	Γ	T	7		Τ	T	T	T	T	T	T	1				T	T	T	T	7	
			Max	3.084		13.080															
	Lond O	U nrsj	Min	3 053	7000	12.901								_							
	70 07 7000	306/ [6.6/	Std Dev	0000	0000	0.021															
		rom 600 to	Average Std Dev Min	2 07A	0.070	13.040															
		2.844 Statistics from 600 to 306/ [6.6/U nrs]			7	Win															
) AC	2.844	2 844		2.844	2.844	2.844	2.845	2.846	2.848	2.851	2.854					2.863	2.866	2.868	2.870	
	Win	11.905	11 008	200:11	11.918	12.711	13.012	13.023	13.045	13.058	13.051	13.045	12 054	10.02			13.048	13.053	13.043	13.048	
		0.238	8660	0.430	0.238	0.254	0.280	0.280	0.281	0.261	0.281	0 281	0.20	0.201	0.261	0.261	0.281	0.281	0.281	0.261	
	XC.	0.569	000	0.308	0.569	0.569	0.589	0.569	0.569	0.570			0.0	0.57	0.57	0.572	0.573			1	
		2 844		7.044	2.844	2 844	2 844	2 845	2 846	2 848	2 851	2 054	4.034	2.826	2.859	2.861	2 863	2 RAR	2 888	2.870	
	lime [sec]	47		2	87	111	87	70	101	447	127	170	13/	147	157	167	477	187	107	207	

This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items	checked:
☐ BLACK BORDERS	
☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES	
☐ FADED TEXT OR DRAWING	•
BLURRED OR ILLEGIBLE TEXT OR DRAWING	
☐ SKEWED/SLANTED IMAGES	
☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS	
☐ GRAY SCALE DOCUMENTS	
☐ LINES OR MARKS ON ORIGINAL DOCUMENT	
☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUAL	HTY .
OTHER:	

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.

THIS PAGE BLANK (USPTO)